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Plastics

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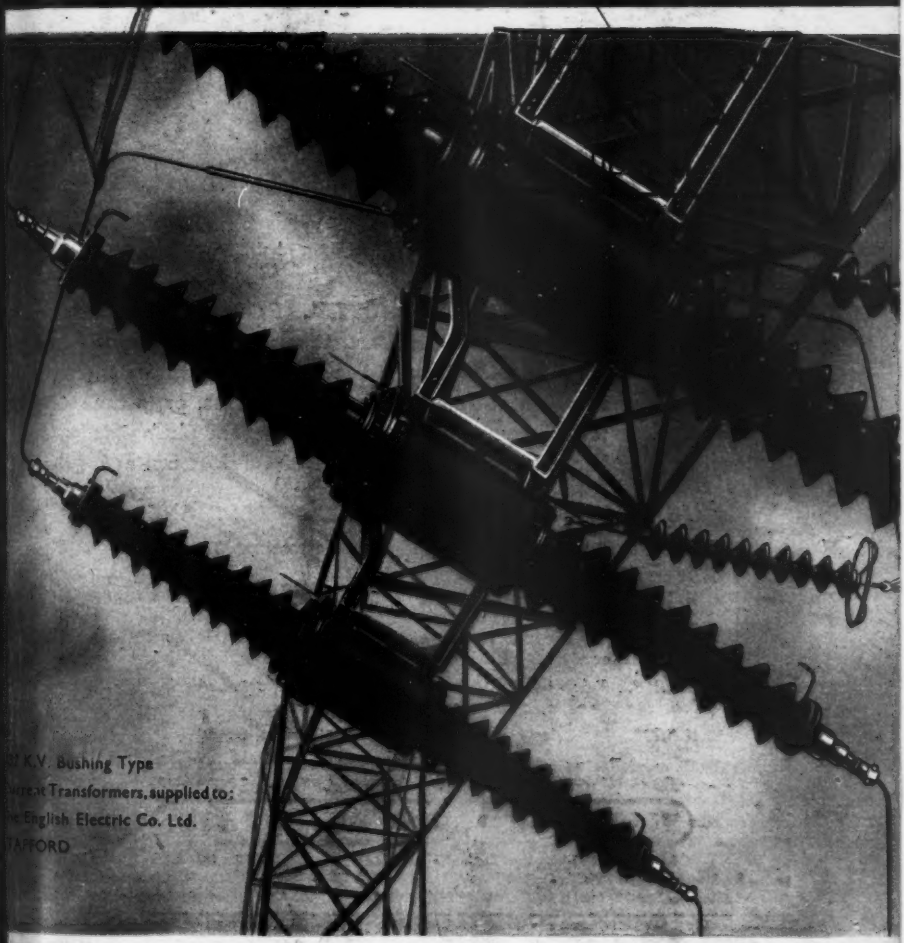

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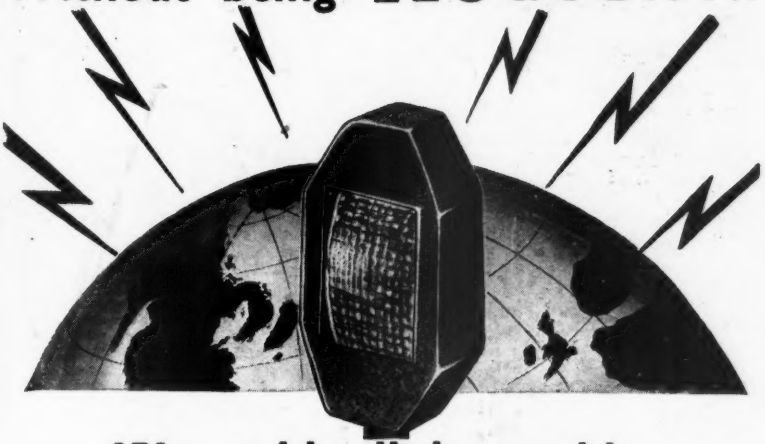

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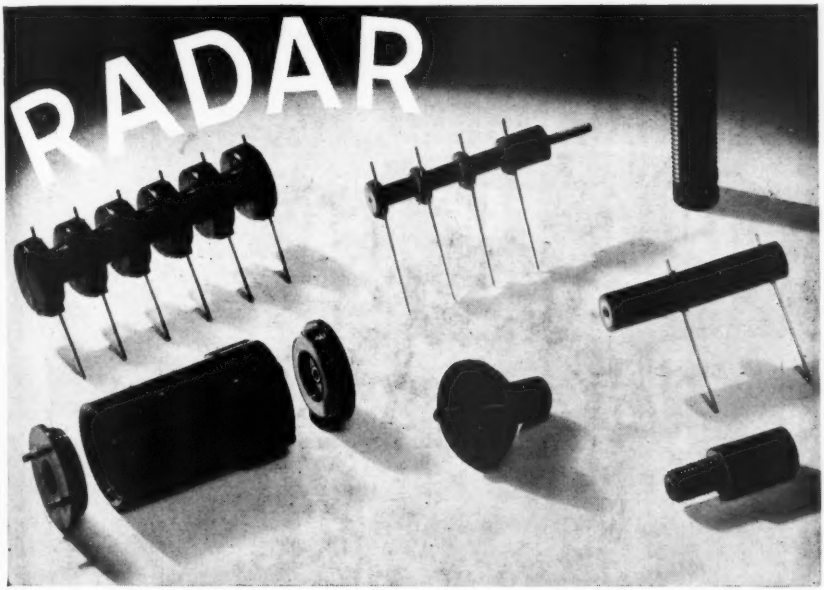

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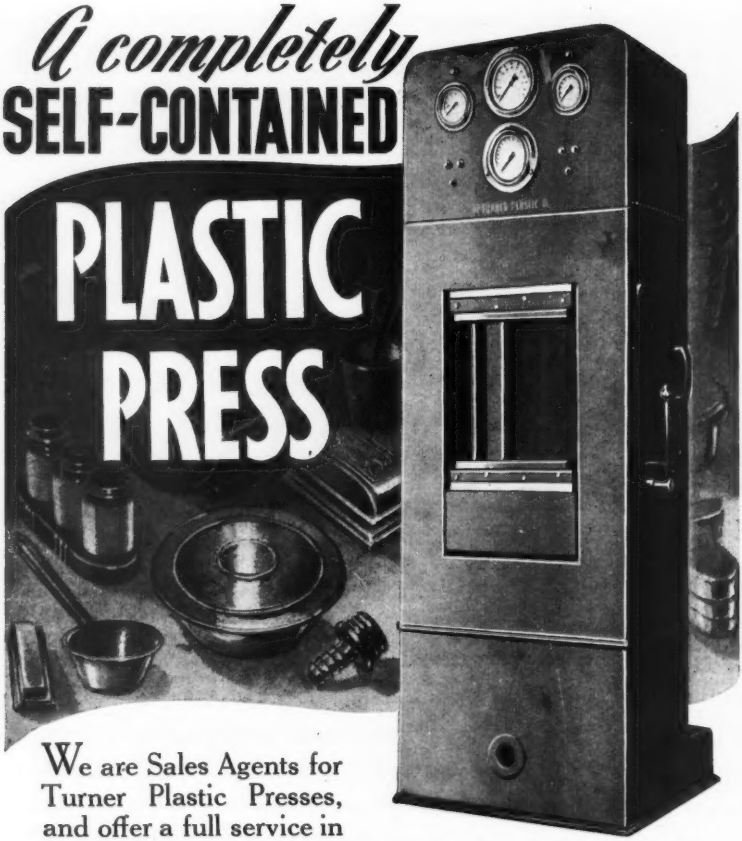

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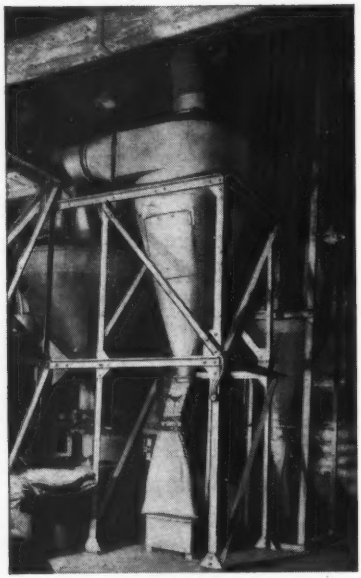

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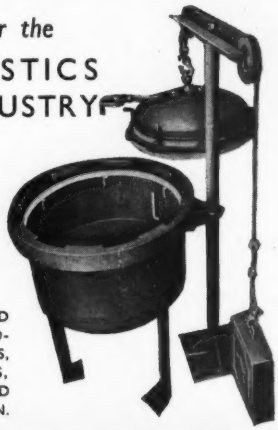

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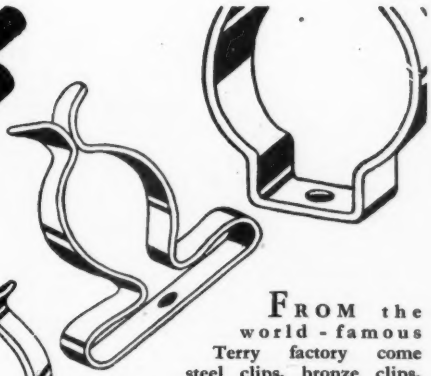

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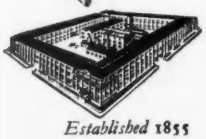

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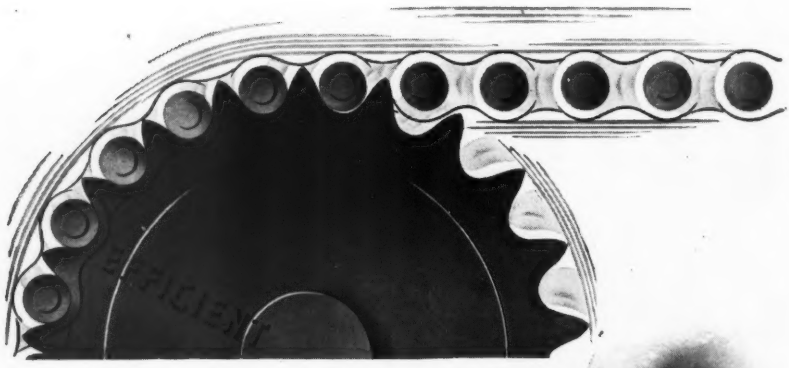

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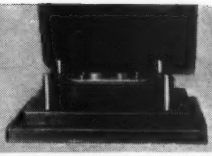

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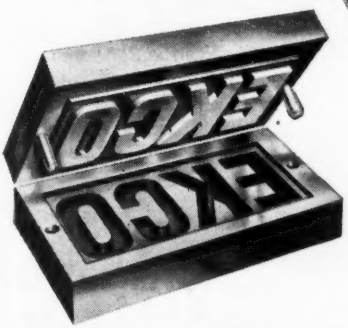

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Vol. X. No. 107 APRIL, 1946

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

Proprietors - - TEMPLE PRESS LIMITED
Managing Director - ROLAND E. DANGERFIELD

Editor - - M. D. CURWEN, B.Sc., A.R.I.C.
Offices - Bowling Green Lane, London, E.C.1

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NOTICES

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EDITORIALS

Control of German Chemical Industry

IN previous issues we have reported the decisions reached by the Quadrupartite Control Commission in Germany regarding the production of German manufactures of heavy chemicals which are to be limited to her internal needs. Exports of this type are clearly not to be permitted.

Another facet of the problem of preventing future aggression by Germany has been brought to light by J. Davidson Pratt, Director of the Association of British Chemical Manufacturers, who pointed out, at a recent Press conference, that no reference has yet been made to the even more important organic branch of German Chemical Industry. Mr. Pratt points out that while no decision has been reached, proposals are now under consideration to allow Germany freely to resume export of dyestuffs and pharmaceuticals to provide foreign currency with which to pay for the imports she will be compelled to make in order to live.

Similarly, until we know to the contrary, it may be assumed that plastics come under the same "harmless industry" category as dyestuffs and pharmaceuticals so far as the Control Commission is concerned, and that they will be freely exported.

The Association of British Chemical Manufacturers take a very different view as to the harmlessness of the two latter industries. So, in fact, do we.

In brief, states Mr. Pratt, the chemical industry is the essentially basic industry, in that every other industrial activity including agriculture depends on it for essential raw materials. It is also the most creative of all industries in that it can discover, invent and produce entirely new materials to take the place of those provided by Nature and indeed develop substances with special properties which have no counterpart in Nature. It is, therefore, necessary in the interest of world peace to ensure that the special war potential of Germany's chemical industry is either eliminated or adequately controlled. Control of chemicals is far more important than the control of steel.

The strength and military potential of the powerful German chemical industry were largely derived from her dyestuffs industry, as witness the name I.G. Farben Industrie. If Germany's organic chemical industry is to be maintained then this will necessitate a high level of output in the heavy chemical industries which provide the basic raw materials for the organic chemist, and this even though the exports of heavy chemicals may themselves be prohibited. The effect will be to maintain a strong German chemical industry with special equipment and facilities capable of easy adaptation and expansion to the production of munitions of war, and, what is even more important for the purposes of war, of a large army of industrial scientists and technicians trained and practised in all the complex process of chemical production. It cannot be stressed too strongly that men who know how, are far more important than mechanics.

All of the foregoing argument applies also to the plastics industry and perhaps with more force. The production of the raw materials is an integral part of the chemical industry, and what happens in the plastics industry may directly affect the whole and vice versa. The production of synthetic polymers and condensates was definitely part of the German Four Years Plan and part of the war plan, witness the production of synthetic rubber and the production of plastics in general to take care of the known shortage of metals in any war that Germany was to undertake.

We all see the need for a balance of German imports and exports, and that we cannot throttle all her movements and

industries. It is vital, however, for the future of world peace, to control the armies of chemical experts in that country by limiting severely the activities of the organic chemical industry.

There seems to be no other solution except that Silesia, the Ruhr and the Saar pass into other hands.

Welding of Plastics

DURING the early part of the war, as a result of a visit to the works of Arc Manufacturing Co., whose history was then almost solely bound up with the welding of metal, we were able to see some of the beginnings of the art of welding plastics. It is now over a year ago that we prevailed on two of the scientific workers in that company to tell our readers something of this small but fascinating industry. The articles they wrote have been quoted the world over.

It was with considerable pleasure, therefore, that we attended on Wednesday, March 27, at the Waldorf Hotel a meeting of the Institute of the Plastics Industry, at which the same two workers, Mr. G. Haim and Dr. H. P. Zade, not only brought our knowledge of existing methods up to date, but widened their number and their scope.

Our readers will have already read of the basic principles of gas-welding and of high-frequency welding of thermoplastics. The most recent addition to these processes is that of friction welding, which appears to have been strongly developed in the U.S.A. Here, again, we have the production of heat at a desired point, this time by the conversion of frictional energy. It all seemed supremely simple as displayed by the authors of the paper, and, indeed, all that seems necessary is the pressing of rapidly rotating or otherwise moving plastic members together for them to be securely joined in the space of a few seconds. A lathe and chuck appears all that is wanted to carry out a large number of different jobs.

We earnestly hope this industry will increase in industrial value as it surely deserves. It does not, we believe, cut across any other existing plastic fabricating process; indeed, we believe it augments many others or cuts new paths for our materials in the markets of the world. During the war, it solved many problems of joining thermoplastic sheet together, especially for the tropical packaging of valuable objects. To-day, diathermic heating of p.v.c. for tobacco pouch and waterproof manufacture is well known.

The gas-welding process appears of greatest value in the chemical industry, where acid-resisting vessels, condensers and the like of special design, shape and size and limited in number exclude any form of mass-production moulding or fabrication. We were interested to see, too, the production of small chemical vessels, such as filter-funnels, made by this means.

This process and that of friction welding no doubt embrace a wider range of materials than does high-frequency welding. Whereas the latter cannot weld two pieces of polythene or polystyrene together because of the extremely low power-loss of these materials, we presume that their welding can be performed by the former methods.

While it is too early to guess the probable future of friction welding, the examples shown by Mr. Haim promised much. We were especially intrigued with the welding of transparent Perspex to red Perspex, and again on the same rod to black casein. This is the first time we have seen a multi-coloured job so " clean cut " in its divisions.

It was once said by a well-known worker in the plastics industry that once we can do multi-coloured mouldings, plastics would have a new lease of life. These are not mouldings, but they give us the next best thing.

Designs for 1946

ON another page in this issue we publish a blue-print of some pleasant and useful designs in plastics, produced in the offices of Mr. George Schueler, consultant, who, it will be remembered, recently

contributed some useful notes on the properties of coconut shell flour as a filler in phenolic moulding powders.

We think these designs have considerable merit, and may or may not require modification, according to opinion.

For our part, we do not wish to stress any special merit they possess, but in publishing them as good, unpretentious, workmanlike jobs, do so in the hope that manufacturers may feel the urge to "go one better."

Never was there a time when this country needed the vitalizing power of art in industry more for both export and home trades, and if this can be married to the fine-quality production and ingenuity that already exists in Britain, then so much the better.

Exhibitions and Exhibitions

ARE we becoming alive to the importance of exhibitions? The war-time creations by the Government and the daily papers for propaganda purposes started the ball rolling with a new high level of excellence with designers given full play for their genius. "Plastic" exhibitions and "new home" exhibitions have added further impetus to it and we are promised a "Britain Can Make It" one in September. Furthermore, the British Industries Fair is to continue its annual run beginning in 1947 and, mirabile dictu, a Government committee has just announced a recommendation that a Universal International Exhibition should be held in London in 1951. "If such an exhibition is organized," says the recommendation, "it must be a dynamic success. No money or effort should be spared to guarantee that it will surpass any previous event of the same character. . . . It should surpass the New York World's Fair of 1939 in scale and technical achievement and the Paris Exhibition of 1937 in æsthetic excellence and personal appeal."

How such talk warms our hearts, and, if it is followed by decisive action, it will invigorate our trade and industries beyond all imaginings.

We wish similarly inspiring hopes and promises had been made regarding the British Industries Fair, which, except for the war period has happily become an annual trade show—that there would be some guidance, even insistence, on the improvement of display.

With very few exceptions there was always an overcrowding, an overloaded show on each stand that blurred the perception of the visitor and killed any attempt of æsthetic value. This was especially noticeable at Birmingham, where engineering exhibits predominated and one could move around, seemingly for hours, each of dozens of different manufacturers displaying exactly the same products. A thousand pots and pans and a thousand stone hearth surrounds can be boring to view in the mass.

And then there is the weather. The merry month of March as a choice for exhibitions is not the happiest, and we have never been to the B.I.F. at Birmingham without being half frozen. Foreigners must think we are quite mad, and few would willingly attempt the journey a second time. We hope the B.I.F. will be really centralized in London and a warmer month be selected.

We wonder if the Government Committee has a secret wish to emulate the famous Leipzig exhibition. We sincerely hope so for we have always considered that it was the best in the world. If there is one thing that attracts the multitude and the industrialist it is "seeing the wheels go round," and we certainly found that at Leipzig in abundance and rarely at the B.I.F.

We visited Leipzig in 1939 and saw full-sized textile machines turning out carpets and 6-ft.-wide "blankets" from the raw material to finished cotton wool, and dozens of plastic presses turning out grosses of finished mouldings. It was all superb showmanship, an art we have not hitherto possessed.

We have now the chance to strike a big blow for the future of British industry. Let us take it.

Wet Strength Improvement of Paper

By C. H. Butcher

IN the technical literature as recently as 1936 there are few references to "wet strength" as one of the desirable features of paper in certain of its uses. In 1943, however, fully 70 such references occur, of which about 25 relate to the obtaining of this improved property by synthetic resin. Wet strength expresses the percentage of retention of tensile strength when the paper is thoroughly wet, by comparison with tensile strength in the dry condition.

Importance of Improved Paper

There are recognized uses for paper with a definitely good resistance to breaking or tearing in the wet state. For example, enhanced wet strength is a very desirable feature for paper towels and lavatory tissue; also for food wrappings, paper bags (intended for shop use, to carry fish, soft fruit, or moist green vegetables), and cartons for materials which are likely to be stored in a moist atmosphere or otherwise under damp conditions, for example, in tropical climates.

There is also a considerable use of large paper bags for the shipping of certain foods which are naturally moist, also animal feeding stuffs; these bags may deteriorate readily because of the semi-moist nature of the contents apart from external dampness during shipment. In all these uses paper has need to be something more than cellulose fibre held together by mere inter-bonding as obtained in normal papermaking practice.

The tub sizing of paper with glue or gelatin, subsequently exposing the glue to the action of some hardening agent such as alum or formaldehyde, produced a certain degree of wet strength, but the use of such paper was limited so far as situations of usage needed paper with enhanced wet strength. As other methods came to be suggested, it was often found that any improvement in wet strength was accompanied by adverse changes in softness, absorbency, mere dry tearing, and endurance to constant folding. As regards papers which have been treated to make them water repelling or merely rather more difficult to wet, it has been found that these do not readily lose their strength when exposed to water, but once they become saturated they are little stronger than the corresponding grade of paper in its normal absorbent form.

For higher degrees of wet strength, the papermaker is now fortunately able to adopt a treatment which involves the production of synthetic resin in the finished paper. Condensation products of urea and formaldehyde, and of melamine and formaldehyde, find greater favour than any other. These methods of treatment have been so highly developed that wet strength for a strong Kraft paper may now exceed the dry strength of a good soft tissue. Towel paper made from pure chemical pulp, normally having a dry tensile strength of 2.00 lb., may show a wet tensile strength of only 0.12 lb., so that the true strength when wet is but 6 per cent. of the strength when dry. Such a paper, properly impregnated with a urea-formaldehyde resin, may now have its wet strength raised to 36 per cent. Kraft wrappings with a wet strength of only 6 per cent. can be treated with either urea-formaldehyde or melamine-formaldehyde resins to increase the wet strength to something between 36 and 48 per cent. Certain forms of the resin may even be added to the papermaking stock and precipitated on the fibre with alum in much the same manner as rosin size is precipitated.

Patent Literature

Brit. Pat. 502,724 was one of the first sources of information regarding the property of enhanced wet strength being conferred upon paper by use of a urea-

formaldehyde resin. Granted to Scott Paper Co. in 1939, it describes a process of incorporating paper stock with a water solution of the resin, preferably in the form of dimethylolurea, together with an appropriate catalyst, the resin being polymerized in situ.

One of the interesting features of urea-formaldehyde resin applied in the form of dimethylolurea, and strictly limited in amount, is its ability to confer a relatively high degree of wet strength with no apparent change in other paper properties. Small amounts of the resin, from 0.5 to 5 per cent. calculated on dry weight of paper, appear to form inside the actual cellulose fibre from which the sheet is built up, thus avoiding any increased inter-bonding and therefore without detrimental effect on flexibility. Only with larger amounts of the resin does the paper show any ultimate tendency to become hard and brittle. Under the most favourable conditions, treated paper is almost indistinguished from the same grade untreated, so far as concern physical tests other than wet strength; there is certainly little change in flexibility or water absorbency.

U.S. Pat. 2,325,302 (K. W. Britt, assigned to Scott Paper Co., 1943) gives a discussion of the mechanism by which wet strength is acquired when employing a synthetic resin. "There are introduced into the cellulose structure resin-forming ingredients either in the unreacted, the unpolymerized, or the partially reacted state, and thereafter the reaction or a completion of the reaction between these ingredients is effected to produce the desired result. The materials from which the resin is formed should enter the cellulose structure in the form of a water solution, and for this consideration to be fulfilled the materials should be in the form of compounds of low molecular weight. These materials having penetrated the cellulose structure are caused to undergo a condensation or polymerization as result of the application of heat in the presence of a catalyst, and this reaction results in the formation within the cellulose structure of a water-insoluble resin, the formation of which, particularly in that part of the cellulose structure where two fibres have been dried in contact with each other, has the result of rendering the cellulose bond substantially unaffected by water."

U.S. Pat. 2,309,089 (J. V. Bauer and D. M. Hawley) effects an increase in wet strength without destroying flexibility by using a urea and an aldehyde in water soluble form while the paper is in wet condition, at some stage prior to final drying, and then separately adding an acidic solution to the dried paper. U.S. Pat. 2,309,090 (Bauer and Hawley) describes a method of treatment for paper which is normally water-permeable, increasing wet strength without decreasing water absorbency. Here the paper is treated in sheet form, using urea and formaldehyde solutions, and an acid-reacting catalyst capable of rapidly penetrating the paper fibre. The urea and formaldehyde solutions are brought in contact with the sheet from opposite sides, and the treated sheet is wound into a tight roll while still retaining 3 to 10 per cent. of moisture. The increased resistance to tearing while wet is developed without heating while the paper stands in roll form.

U.S. Pat. 2,338,602 (M. O. Schur) incorporates with the paper stock, prior to web formation, about 0.125 per cent. or more of a reaction product of urea and formaldehyde carried to the stage where viscosity of the solution has sharply risen and still mounts rapidly, but has not yet reached the gel stage.

As alternative to urea-formaldehyde, certain advantages accrue from use of melamine-formaldehyde resins. Hofmann, in 1874, first found that melamine (1.3.5-triamino-2.4.6-triazine) produces a resinous product; but it was not until 1939 that melamine-formaldehyde resins were introduced commercially. This was mainly due to the high cost of melamine, which for long was in the neighbourhood of £8 per lb. Commercial production was made possible from researches by American Cyanamid Co., who have likewise been intimately concerned with the

development of melamine resins. It is also desirable that melamine-formaldehyde resin be incorporated with the paper stock in form of an intermediate reaction product, and to complete the polymerization in situ in the cellulose structure. A given amount of either urea or melamine resin is said to confer about the same degree of wet strength; there is no further increase if resin in excess of 5 per cent. of dry weight of paper is employed.

Brit. Pat. 540,673 (American Cyanamid Co.) obtains increased wet strength by treating paper with an aminotriazine-aldehyde condensation product; in melamine, as such product, it is the three amino groups which are especially reactive and permit condensation with aldehydes to yield a resin. U.S. Pat. 2,291,079 (R. P. Hofferbert, assigned to American Cyanamid Co.) proposes the use of a water solution of melamine-formaldehyde resin calculated at 0.5 to 5 per cent. of weight of paper on dry basis, and obtains polymerization by heating the treated paper to about 150 degrees. U.S. Pat. 2,291,080 (same) relates to like use of an aminotriazine-aldehyde condensation product.

U.S. Pat. 2,322,887 (G. L. Schwartz and J. F. Walker, assigned to E. I. du Pont de Nemours) makes use of an aqueous starch dispersion containing a water soluble methylolmelamine (1-25 parts per 100 parts starch), a polyvinyl alcohol (1-25 parts per 75 parts starch), and an ammonium salt such as ammonium chloride. The treated paper web is heated to a temperature sufficient to cause an insolubilizing reaction between the starch and the methylolmelamine. Modifications are given in U.S. Pat. 2,322,888.

As to preferred technique in the use of melamine-formaldehyde resins for paper treatment, Maxwell (Paper Trade J., 1943, No. 19, 39) gives valuable information. The melamine resin, in form of a finely pulverized white powder, is dissolved in a mixture of warm water and hydrochloric acid, and then diluted with cold water to a strength of 12 per cent. resin solids (1 lb. dry resin per gallon). This solution is allowed to age for at least 12 hours, and is then ready to be added to the paper stock after all beating and refining has been completed. Under normal conditions, the resin solution will keep for several days, but eventually it gels and is then unfit for use. The treated paper, as it leaves the machine, has appreciable wet strength, but this improves after ageing for several days. In amounts normally used, the hydrochloric acid lowers the pH value of the paper, in extent depending on the buffering capacity of the mill water. Should this increased acidity be undesirable, it may be neutralized either before or after the addition of the resin to the paper stock. The rate of polymerization or "cure" is fastest at low pH values, the normal papermaking range being 4.5 to 6.0. It is said that any of the usual paper-sizing materials and fillers can be used in conjunction with melamine resin treatment, which not only gives enhanced wet strength but also improves fastness against the bleeding of dyes in water.

The use of synthetic resins other than those obtained by urea-formaldehyde and melamine - formaldehyde condensations has been suggested for improving the wet strength of paper, but other products have generally proved objectionable for reasons of odour, resulting colour changes in the paper, or difficulty of application in form of water solutions. In the case of urea and melamine, the condensation reaction completes itself under normal conditions of papermaking. Methods of application rather than the properties permanently belonging to these resins is the cause of any difference in wet strength ultimately obtained. Actually, melamine-treated paper acquires a wet tearing strength which is little superior to urea-treated paper, when the resins are applied under like conditions in the tub. With urea, however, a much greater loss of wet strength occurs with age, as compared with melamine; in other words, the melamine resins prove more resistant to hydrolysis than do the urea resins. Conditions prevailing during the storage of the treated paper also enter

(Continued on p. 224)

Letter to the Editor

Film Criticism

Sir,—I was very interested to read your opinion, printed in your March issue, of the documentary film entitled "Plastics."

To an enthusiast and expert on the subject like your good self, the film must certainly have appeared to lack a great deal, and I do not, therefore, suggest that your comments, as such, are altogether unjustified, though, even so, I think your general criticism somewhat severe.

The essential point is—and you are, I believe, well aware of the fact—that during the war our industry was engaged to about 95 per cent. of its capacity on war work. How, therefore, could the film indicate why plastics has (as you point out) so fundamentally transformed the electrical industry, when, in fact, those concerned in such great work were prohibited by law from allowing any pictures to be taken of such and many other equally important activities, because, of course, the film was made during the height of the war.

The British Council had the fullest support and co-operation of the British Plastics Federation in the production of this film, and we seriously considered, in the first place, whether, in view of the restrictions on photographing our manufactures, such a film could in fact be produced. That it is as good as it is, reflects the highest credit on all those who were concerned with its production.

A film of this sort, showing for some 20 minutes, must obviously be superficial, and would only be exhibited in the leading West End and provincial cinemas if it had sufficient popular appeal. The reception the film has received from the public proves that it has accomplished at least one desirable object, which is to remind the British public of the ramifications and interests of our industry, even though the angle of importance could not be stressed.

At the time this film was "shot," I was chairman of the British Plastics Federation, and, therefore, in the opinion of our present chairman—Mr. Charles Waghorne—it is more appropriate that I should remind you of the foregoing facts and circumstances.

H. W. GRAESSER-THOMAS,
Immediate Past-chairman, The British Plastics Federation.

Reply by the Editor

Sir,—May I thank you for your letter of the 22nd? I regret you thought my criticism of the film too severe.

The fact that it contained no reference to war-time discoveries, such as those that affected plastics in the electrical and other industries, had nothing whatsoever to do with my comments. Indeed, had they been included I should have been still more critical, for they would have confused the real issue, so far as I consider it, still more.

I believe that to get a healthy appreciation of plastics by the public we must go back to first principles and try to explain, to give a simple example, why the old, ugly and inefficient telephone of 1910 has been supplanted by the lovely efficient thing our 1946 brunette held to her ear. It was certainly not because of the mere change in colour, which is what the British Council appears to think. There were dozens of similar examples in the film itself, but comparisons were never exploited.

I believe you are under the impression that I would have preferred a truly scientific and technical film. Nothing was farther from my thoughts, unless you consider the annual lectures at the Royal Institute truly scientific. I insist that telling the people "the why and the wherefore" can be made both instructive and entertaining. Even the dance of the molecules can be made so in the space of three cinema minutes. I deny, also, that a film of this sort of 20 minutes' duration must be superficial. The best documentary as well as some of the best short stories of the world take no longer to unfold.

I suggest that the film added nothing to the stature of the plastics industry, nor to the intellectual pleasure of the public.

My opinions may be right or wrong, but I hate the specious, the pretentious and, in the film under discussion, the over-emphasis of a characteristic merely because it proved the most facile to produce a psychological effect.

However, if the Federation is content merely to remind the British public of the ramifications and interests of our industry, there is little more to say. I should have thought the daily Press do that aspect of it quite well.

In spite of the foregoing remarks, I feel sure you will agree that each of us is aiming, in his own way, at one end, namely, the welfare of the plastics industry.

M. D. CURWEN,
Editor.

IDEAS IN PLASTICS FOR 1946

THE BOX ~ AN ATTRACTIVE NOVELTY TWO-COMPARTMENT BOX ~ OPENS EASILY WITH ONE-FINGER ACTION.

INJECTION MOULDED WITH METAL INSERT HINGE OF UREA PLASTIC IN PASTEL SHADE OR TRANSPARENT PLASTICS ACRYLICS, ACETATE, ACETO-BUTYRATE.

THE LAMP ~ STREAM-LINED CYCLE LAMP ~ ENSURES SIDE LIGHT ~ DIMINISHES ACCIDENTS

COMPRESSION OR INJECTION MOULDED IN TWO PARTS WITH FORMED WINDOW ~ SHOCK-PROOF PHENOLIC FOR THE BACK, BRIGHT COLOURED UREA FRONT, TRANSPARENT WINDOW SHEET.

THE HANDLE ~ SMART UMBRELLA HANDLE WITH RESILIENT CORD AND GOOD WARM GRIP.

MOULDED P.V.C. ~ ASSEMBLED WITH EXTRUDED CORD AND BEADS TO MATCH ~ FROM P.V.C. COVERED WIRE EXTRUSION

THE CABINET ~ DECORATIVE RADIO CABINET IN TWO COLOURS WITH REMOVABLE TOP, BOTTOM AND BACK FOR FULLEST INSPECTION AND RAPID REPAIRS

COMPRESSION MOULDED TRAYS FROM SHOCK-PROOF PHENOLIC ~ BRIGHT COLOURED CURVED FRONT AND SIDES FROM LAMINATED SHEETING ~ GLASS FIBRE FABRIC OR PLASTIC COATED YARN FOR SPEAKER COVER

EXAMPLES OF COMMERCIAL APPLICATIONS OF VARIOUS PLASTIC MATERIALS WHERE THEY CAN COMPETE SUCCESSFULLY WITH TRADITIONAL PRODUCTS

ORIGINAL DRAWINGS FROM THE OFFICES OF - GEORGE B E. SCHUELER

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The Microscopic Examination of Plastic Materials

VI.—Mouldings: (a) Fillers (Wood Flour)—contd.

By J. H. WREDDEN, F.R.M.S.
(Chief Chemist, Igranic Electric Co., Ltd.)

ON returning to our examination of the deciduous woods, it is proposed to take as the first example the wood of the plane tree, which is considered to be one of the softer "hardwoods." This is illustrated in cross section at 100 diameters in Fig 73.

Here we encounter an entirely different structure from that exhibited by the conifers, although the basic elements are similar, that is to say, the structure is built up of xylon, phloem, cambium and so forth; we find a different arrangement and new types of xylon elements make their appearance. This photomicrograph shows two medullary rays (A) in the xylon tissue. These rays will be seen to consist of cells closely set together and massively constituted, when compared with those in the coniferous woods, containing large numbers of parenchymatous cells. The most important difference lies in the actual xylon tissue, which is seen to consist not of just one type of tissue element, as in the conifers, but several types ranging from large vessels, such as that shown at (B), which are rich in lignin, to the small tracheids, groups of which are shown at (C). These latter are interesting inasmuch as they are very numerous and would appear to form a matrix in which the larger tracheids and vessels are embedded.

In order to make this quite clear, let us examine these tracheids at a higher magnification. Fig. 74 shows a portion of the same section photographed at a magnification of 300 diameters, from which we see that the tracheids such as those shown at (A) are so much thickened that the bore has been considerably reduced and

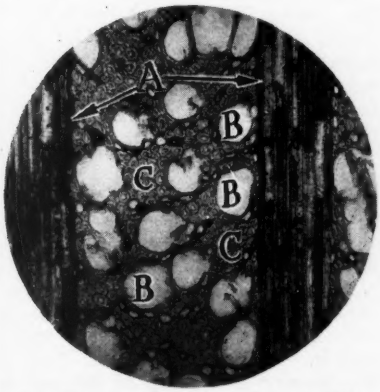


Fig. 73.—Longitudinal section of plane wood tissue. Mag. 100 diameters.

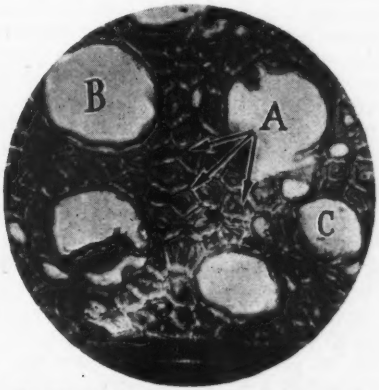


Fig. 74.—Transverse section of plane wood showing massive thickening of tracheids. Mag. 300 diameters.

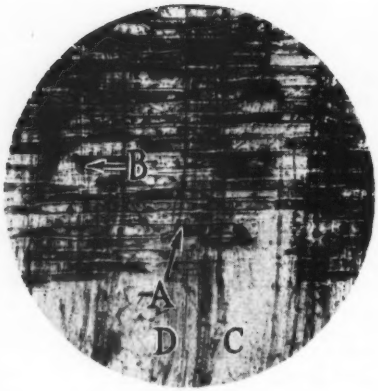


Fig. 75.—Longitudinal section of plane wood tissue showing portion of medullary rays. Mag. 100 diameters.

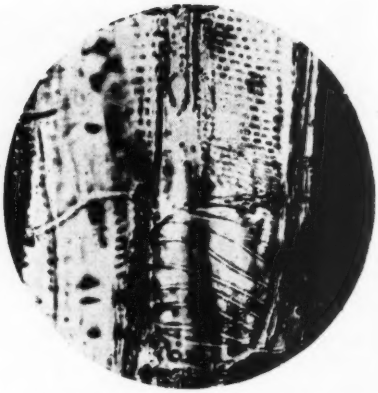


Fig. 76.—Longitudinal section of plane wood, showing spiral vessel. Mag. 300 diameters.

in some cases almost obliterated. This structure shows the reason for the hardness, for the thickening would appear to consist of pure ligno-cellulose, with few, if any, pits or surface variations to weaken the structure, thus producing a very strong tissue element. The whole tracheid area is closely packed, the vessels fitting into one another forming a dense structure as a result.

Interspersed in this mass of tracheids are the large vessels (B); these have patterned lignification of one type or another and whereas it would seem that they tend to weaken the structure of the wood in general, they would not appear to have much of a weakening effect when the wood is reduced to flour, providing that the flour is made in such a manner as to preserve the fibrous nature. Also in this illustration will be seen the smaller vessels as at (C), these, of course, possess patterned lignification as in the case of the large vessels.

Now suppose we examine this wood in longitudinal section as shown in Fig. 75, at 100 diameters, where we see a portion of a medullary ray running horizontally. This will be seen to differ from the medullary rays in the coniferous woods, inasmuch as they do not possess tracheids but consist wholly of parenchymatous tissue. In the case under discussion it will be noticed that a number of the cells in the ray still retain their contents, as in the one shown at A, in some cases the nucleus is present as at B. This condition is mentioned in order to illustrate once again the importance of using fully matured heart wood. In this example the wood is obviously immature as indicated by the presence of the cell contents in the medullary ray shown, thus we have a valuable means of identifying the presence of immature wood, but it should be borne in mind that in many cases when the medullary ray dies, the cells become pigmented; therefore, before passing judgment on any particular specimen suspected of being immature, the presence of nuclei or their remnants should be indubitably established, as this is an infallible indication of immaturity.

Proceeding with our examination of this section, we see various types of thickening in the longitudinal elements, thus at C we have a pitted thickening consisting of small horizontal pits closely spaced, this is one of the larger vessels seen in the transverse section. Next to this element is a group of the heavily thickened tracheids shown at D. This view of these elements gives a somewhat

clearer picture of their function, as they may be compared to the strong bast fibre of the phloem region; therefore, it will be seen that the greater part of this deciduous wood is made of a material comparable to the strongest element found in the coniferous woods, which occurs in this latter only in small amounts in the bark.

The thickening of the larger vessels in the deciduous woods is interesting, as in no case do we find the type of pits so characteristic of the conifers, these being unnecessary in the deciduous woods as there are no resin ducts. The thickening is at liberty, as it were, to take the most suitable form. Thus in Fig. 76 we see a portion of the same section illustrated in Fig. 75, at a magnification of 300 diameters, wherein is shown two large vessels, one of which is spirally thickened and the other pitted. This illustration shows the type of pit found, somewhat more clearly, and demonstrates the greater degree of lignification encountered in this type of vessel, as compared with the spiral vessel. It might also be pointed out here that these large vessels are responsible for the minute hole or pores distinguishable by the naked eye in the hardwoods; thus as the wood of the plane trees possesses a large number of these vessels, it will be seen very clearly why it is one of the softer deciduous woods.

Another reason for this characteristic exists in the structure of the medullary rays. These are seen in transverse section in Fig. 77, which is a photomicrograph of a tangential section of plane wood, at 100 diameters, the medullary rays "A" are seen to be massively constructed, and as they are composed of parenchymatous tissue they are quite soft, and therefore reduce the strength and hardness of the wood in general, likewise the presence of all this unsuitable tissue will have an undesirable effect on wood flour produced from this material.

In concluding this brief survey of the hard woods, it is proposed to examine a material somewhat harder than the plane wood in the form of the common Banksia, a transverse section of which is seen in Fig. 78 at a magnification of 150 diameters. It will be seen that whereas the structure appears to be more open than in the case of the plane wood, in reality the Banksia would be expected to be harder as the large vessels are more highly lignified, indicated by the greater wall thickness; likewise their average diameter will be seen to be below that of the plane. The thickening of the tracheids is considerably heavier. (This illustration is at 150 diameters and that for the plane wood, Fig. 73, is 100 dia-

Fig. 77.—Tangential section of plane wood. Mag. 100 diameters.

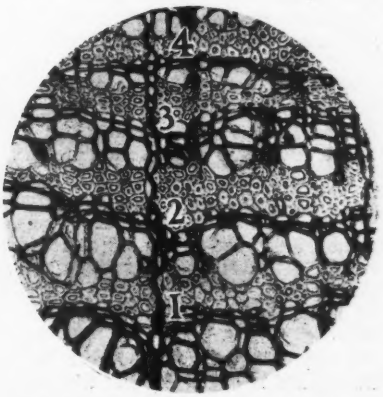


Fig. 78.—Transverse section of Banksia. Mag. 150 diameters.

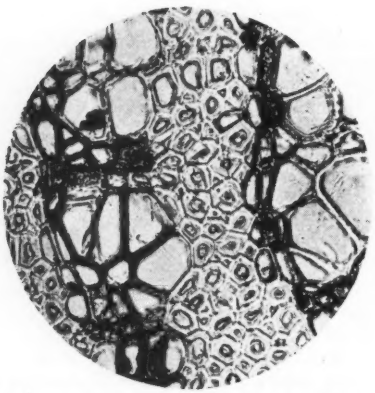


Fig. 79.—Transverse section of Banksia. Mag. 300 diameters.

Fig. 80.—Longitudinal section of Banksia. Mag. 300 diameters.

meters, the difference in the compactness of the structures of these two woods will become apparent.) Thus, in the case of the Banksia, we see four annular rings, 1, 2, 3 and 4, of varying width, this probably being due to variations of growing conditions, wherein the tracheids occupy about 50 per cent. of the cross-sectional area. The medullary ray traversing the centre of the illustration in a vertical direction is seen to be very much less massively formed.

From the foregoing remarks we see that as the wood becomes harder so the degree of lignification of the various vessels increases until we reach such structures as are met with in woods like ebony and oak, where almost the entire structure is composed of massively lignified xylem elements of small diameter with only a few of the larger vessels present.

The question of the compactness of the Banksia will be made clearer by reference to Fig. 79, which shows a portion of the section illustrated in Fig. 78 at 150 diameters. This is the same magnification as that used for Fig. 74, and a comparison of the two will show the greater degree to which the Banksia is lignified. From this we may conclude that the latter is the harder and stronger wood of the two, in consequence of which one would be justified in assuming that wood flour produced from this would be superior to that produced from plane wood. However, as we shall see subsequently, much depends on the method by which the wood is broken down.

If we examine the Banksia in longitudinal section, as shown in Fig. 80, we see again how much more compact is the structure when compared to that of plane wood. This illustration is at the same magnification as the longitudinal section of plane Fig. 76. The difference in size of the vessels is clearly seen and the various forms of pitting in the Banksia are shown, together with a group of the small tracheids, which show no pitting at all. Thus we see that in these deciduous woods we have present all the elements which should go to make a filling material which will confer greater strength on a finished moulding than would be the case with the coniferous woods; these, we have seen, are composed of comparatively thinly lignified xylem elements possessing large pits. There are also appreciable quantities of resin in the conifers, whereas the deciduous woods are non-resinous.

There is one characteristic, however, in which the coniferous woods have a decided advantage over the deciduous, the conifers producing much whiter wood. This is due to very much less pig-

Table I.

Type of wood	Moisture content	Fibre stress at proportional limit (p.s.i.)	
		Static bending	Impact bending
	%		
Cedar (Alaska)	12	7,100	12,200
Cedar, Eastern Red	12	3,800	8,500
Cedar, Incense	12	5,900	9,600
Cedar, Northern White	12	4,900	7,100
Cedar, Port Orford	12	7,700	13,500
Cedar, Southern White	12	4,800	7,600
Cedar, Western Red	12	5,300	8,600
Douglas Fir, Coastal	12	8,100	12,700
Douglas Fir, Inland	12	6,300	11,800
Fir, Balsam	12	5,200	7,800
Fir, Commercial White	12	6,300	11,200
Pine, Lodgepole	12	6,700	9,600
Pine, Northern White	12	6,000	9,500
Pine, Norwegian	12	9,400	15,900
Pine, Ponderosa	12	6,300	9,800
Pine, Southern Yellow (Loblolly)	12	7,800	12,100
Pine, Southern Yellow (Longleaf)	12	9,300	15,400
Pine, Southern Yellow (Shortleaf)	12	7,700	13,600
Pine, Western White	12	6,200	11,900
Spruce, Eastern	12	6,500	11,400
Spruce, Sitka	—	6,700	11,400
Spruce, Englemann	—	6,000	9,000

ment being formed in the medullary rays when they die. The deciduous woods are, as a rule, darker because of the pigment secreted, and, in fact, as the wood gets denser so the pigment increases, as evidenced by the difference between the colour of plane wood, which is nearly white, and ebony, which, as everyone knows, is black. The colour also deepens, and naturally so, as the lignin content increases.

Whereas the colour of the wood flour used for fillers is important when it comes to the question of light-coloured mouldings, this would appear to apply only in the case of U.F. resins and the like. For application to phenolic resins the colour must, of necessity, be less important due to the naturally dark colour of the cured resin; therefore, where wood flour is used for phenolic mouldings it seems that attention must be paid to those characteristics, other than colour, which are desired in the finished article, and as this type of moulding is used more for electrical work than any other type, one would be justified in giving those characteristics which affect the electrical and mechanical properties first consideration.

In order to get a clear conception of the effects likely to be produced by the addition of wood flour to a phenolic resin, let us examine the strength of the various types of wood which are capable of being broken down into flour. As the coniferous woods appear to be almost universally used, it would, perhaps, be as well to examine these first.

The two types of stress which probably give the most information are those incurred in static bending where the outer fibres are in tension and the inner ones in comparison, and impact bending. Thus Table 1* shows the fibre stress and the proportional limit in a number of coniferous woods.

From the foregoing figures it will be seen that the resistance to impact bending is considerably greater than that for static bending. However, our requirement is an idea of the strength of the fibre. As the wood is used in the form of separate fibres not by any means orientated and compacted as in the natural state, it would perhaps be better to take the figure for static bending because its resistance to this type of stress seems to be more nearly dependent on the strength of individual fibres rather than the mass effect which would be encountered in the case of a shock stress such as that experienced in the impact bending.

* After Eshbach. "Handbook of Engineering Fundamentals." John Wiley and Sons.

Thus we see that the majority of these soft woods possess fibre strengths of from 5,000 to 7,000 lb. per square inch, which figure may be safely assumed to be fairly representative of so variegated an assortment of types. However, in the cases of the Norwegian and the Southern Yellow longleaf pines, we encounter strengths in excess of this figure, these two examples showing a fibre strength of over 9,000 p.s.i. Therefore, it would appear that these two types of coniferous wood should produce the strongest mouldings, and no doubt they would if the fibres were allowed to function as such, and not in the capacity of a granular filler, as so often happens when the reduction to flour is too fine and results in the fibres losing this characteristic. We shall, however, discuss this aspect in greater detail subsequently. For the time being, suppose we examine the hardwoods in a similar light. Table II gives similar figures for a few selected hardwoods, and from it we see that the general level of fibre strengths is well above that of soft woods. The average figure for the static bending is of the order of 8,800 p.s.i., with three types having strengths above 10,000 p.s.i., and one over 12,000 p.s.i., from which it may be concluded that the hardwoods in general offer better prospects than the soft woods, in so far as the strength of mouldings is concerned.

One factor which possibly influences their popularity is their availability, but in this respect it will be seen that the strongest of the hardwoods (if we omit the less readily available black locust) are birch, hickory and walnut. However, in general, these strength figures raise some interesting queries pointing to the necessity for somewhat deeper research into the question of the suitability of various types of wood for use as a filling material for mouldings.

Thus we see how a study of the structure of wood has shown that the higher lignification and more compact structure of the hardwoods produce greater strength, as a result of which one would be justified in assuming that the fibres were also stronger, but there is one aspect which we have so far not touched upon, and that is the effect of the moisture content of the wood upon its strength. It is well known that as the moisture content of wood increases so does its mechanical strength decrease, not necessarily by the same proportion in each case, but rather does the decrease in strength depend largely on the type of structure. It will be seen that all the foregoing figures are relative to a moisture content of 12 per cent., and in order that we may appreciate, to some extent, the effects of moisture content, the strengths of some of the examples in each of the two foregoing tables are given in Table III.

Before discussing the results in Table III, it would perhaps be as well to see

Table II.

Type of wood	Moisture content	Stress at proportional limit (p.s.i.)	
		Static bending	Impact bending
	%		
Ash, Black	12	7,200	—
Ash, Commercial White	12	8,900	17,000
Ash, Oregon	12	7,000	13,300
Beech	12	8,700	16,000
Birch (average of Sweet and Yellow)	12	10,100	20,000
Elm, Rock	—	8,000	—
Hickory (True)	—	10,900	22,900
Locust (Black)	—	12,800	21,100
Maple, Black	—	8,300	13,500
Maple, Red	—	8,700	—
Maple, Silver	—	6,200	12,400
Maple, Sugar	—	9,500	20,600
Oak, Red	—	8,400	17,000
Oak, White	—	7,900	17,400
Walnut, Black	—	10,500	16,400

Table III.

Type of wood	Moisture content	Fibre stress at proportional limit (p.s.i.)		Static bend stress of 12% M/C p.s.i.
		Static bending	Impact bending	
	%			
Cedar, Eastern Red	35	3,400	7,000	3,800
Cedar, Northern White	55	2,600	5,300	4,900
Spruce, Stika	42	3,300	8,400	6,700
Pine, Norwegian	54	3,700	7,500	9,400
Ash, Black	85	2,600	—	7,200
Maple, Sugar	58	5,100	12,200	9,500
Walnut, Black	81	5,400	11,900	10,500
Locust, Black	40	8,800	18,300	12,800

exactly what occurs when wood takes up water. Assuming the wood to be quite dry at the commencement, water will be absorbed readily, either as liquid or vapour out of the atmosphere. Owing to the substance of the material being hygroscopic and the structure more or less sponge-like, the material is capable of absorbing large quantities of water in this way until the fibre has reached saturation point, when the vessels begin to fill up under extreme conditions, and the wood starts to become water-logged. It has been estimated that, in general, completely dry wood will absorb up to 15 per cent. of its weight of water from a 100 per cent. saturated atmosphere, the absorption being approximately proportional to the condition of the atmosphere. Thus, with a 50 per cent. saturated atmosphere, the wood will absorb about 7.5 per cent. of its weight of water. All this takes place with the wood in the solid condition: how much greater, then, is this effect going to be when the wood is broken down into flour. Let us examine the examples quoted in Table III.

We see that Eastern Red Cedar, which had an original strength of 3,800 p.s.i., shows a drop of 3,400 p.s.i. when the moisture content is 35 per cent. These latter figures for moisture content are taken from Eshbach, and they are presumably fibre saturation figures. The next softwood, however, Northern White Cedar, drops from 4,900 p.s.i. to 2,600 at 55 per cent. saturation, and so on, as a result of which we see that the hardwoods tend to suffer more under these conditions.

If we assume that the drop in strength is proportional to the rise in moisture content, then it is a simple matter to express this effect as a loss of so much strength (in p.s.i.) per 1 per cent. rise in moisture content, as shown in Table IV, as a result of which we see with dramatic clearness the effect of the moisture content on the strength. Thus the soft woods appear to be less affected than the hardwoods, except for the Norwegian pine, which was the strongest of this type of wood at the standard moisture content of 12 per cent. This is interesting, inasmuch as, in the opinion of Dahl,* the majority of moulding powder manufacturers in this country use Scandinavian softwoods, the reasons given being their whiteness and almost complete freedom from natural resin. We know from the strength of this wood at 12 per cent. moisture content that this reason is justified, but its extreme sensitivity to moisture throws a new light on the subject, as it clearly shows that, when used in the form of flour, very great care would appear to be necessary in controlling the moisture

Table IV.

	Type of wood	Loss of strength (p.s.i./1% increase of moisture)
Softwoods	Cedar, Eastern Red ..	17.4
	Cedar, Northern White	46.5
	Spruce, Stika	11.3
	Pine, Norwegian ..	136
Hardwoods	Ash, Black	63
	Maple, Sugar	95
	Walnut, Black	74
	Locust, Black	100

*Dahl. "Wood flour."

content if the best use is to be made of its strength, particularly so in view of the fact that in this latter form its sensitivity may be assumed to be greatly increased. It should, however, be pointed out that it is generally considered that wood flour should possess a definite water content when used for making moulding powders, as this helps in producing a satisfactory powder. This opinion would appear to be open to debate, as we have seen that moisture in wood reduces its strength considerably, and whereas there are difficulties in the way of using it quite dry, it would seem desirable to keep the moisture content down to the barest minimum. Especially is this so with respect to mouldings used for electrical purposes, because, in any event, we get the presence of the reaction water in the moulding, which, presumably, is absorbed by the filler and is most undesirable.

As a result of this apparent necessity to include a water content in wood flour, special fillers of a mineral nature have been developed for electrical purposes, the best of which is mica, and it would be interesting to know whether the mica flour requires a water content in order to produce an easily workable moulding powder, as it would seem logical that, for the best electrical characteristics, the filler, whatever it be, should be incorporated into the resin in the completely dry state. The importance of this will be appreciated when it is realized that anything from 5 to 8 per cent. of water is liberated into the moulding as a result of condensation.

If we now direct our attention to the loss of strength experienced by the hardwoods, we see that with the exception of the Norwegian pine, they sustain a considerably greater loss than softwoods. This lends some measure of support to the contention that the comparatively great loss sustained by the Norwegian pine was due to the low resin content, as these hardwoods are all non-resinous and, in consequence, more or less hygroscopic according to whether the structure is highly compacted or not; this latter condition will also influence the lignin content. Although in the black locust wood we are confronted with an apparently anomalous condition, as it is the strongest at 12 per cent. moisture content and yet has a loss of 100 p.s.i./1 per cent. moisture increase. This may be accounted for by a relatively open structure possessing large vessels, having a high degree of lignification, which latter characteristic would be responsible for the high dry strength, the loss of which would be facilitated by the ease of access of moisture due to the open structure, in consequence of which larger masses of cellulose and lignin would be functionally absorbent than would be the case with a more even close structure, as found in the black ash, though this does not necessarily signify high dry strength, for the black ash has the lowest strength figure of the hardwoods chosen.

It would seem, therefore, that the hardwoods should produce a stronger moulding by virtue of their superior fibre strength, but require very careful handling due to their extreme sensitivity to moisture content. On the other hand, if the production of a moulding powder filled with really dry hardwood gives a moulding of improved electrical characteristics, as well as increased strength, then any modifications to processing methods and moulding technique required to produce the desired result should be worth while, always assuming that the cost of such modifications does not outbalance the results achieved.

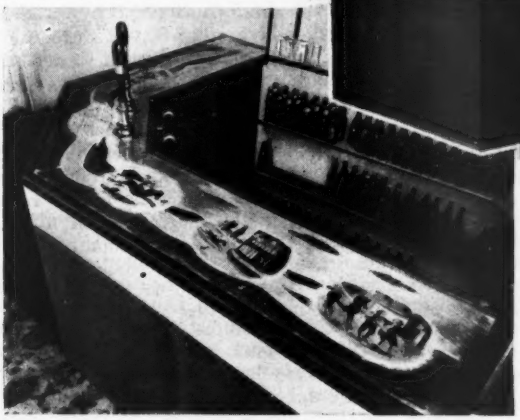
However, these suggestions are put forward in the hope that some slight help may be obtained in improving the quality of the ordinary wood-filled moulding for electrical use, without going to extreme lengths. It should be remembered that, when dealing with the strength of the wood fibre, that its maximum strength is developed with a moisture content of 4 to 5 per cent., so that we gain nothing by using the wood flour in the perfectly dry condition. We also see that there is a limit to the improvement possible so far as moisture content of the finished moulding is concerned.

(To be continued.)

Crossing the Bar

OF our vast experience of pubs the world over, seen through the arches of the years, we could tell a moving tale: of Charlie Brown's in Limehouse to "La Rotonde" in Montparnasse, of long bar in Trocadero and longer bar in Singapore, of "Hermosilla del Norte" in El Paso, and back to the "Hero of Maida" down the Edgware Road.

We could tell, too, of our first pint of "old and mild," of youthful adventures in habanero, tequila, vodka and champagne, of wiser tastes in Nuits Saint-Georges and in the elixir of the monks of Sainte Marguerite, and now serene at last with our first love of English "old and mild."



Perhaps the beverages of the world have not changed much since the beginning of history and Anglo-Saxon ealu and Irish usquebaugh bore some resemblance to their modern equivalents, but it is a far cry from the gin sinks that followed Orange William's coming to our "Chequers," "Rose and Crown," and "Fisherman's Rest" of to-day.

And if you have never noticed the difference but have merely thought in passing that "The Tabard" in Southwark never provided Chaucer's Pilgrims with plastic dart flights, take heed when next you wend your way through Hertfordshire's crazy lanes to stop at the Canon's Hotel, in the ancient town of Ware.

To those who prefer hard technical data to our too agile imagination, we impart the information that, at this rest for the weary, blisterproof, decorated veneers of Warerite for facing the front and top of the bar have been usefully introduced.

The surface of the bar incorporates original designs depicting John Gilpin's famous ride from London to Ware. These designs are painted by the artist on specially prepared paper supplied by Warerite, Ltd. (a unit of Bakelite, Ltd.), and are then fabricated as an integral part of the veneer. Designs are thus protected by the synthetic resin, enabling the scenes to retain their freshness despite hard wear. This method of incorporating original designs does not detract from the normal properties of the plastics materials in their resistance to the effects of heat, alcohol, water, etc.

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Plastics in Germany

The New Target in Germany is the Science behind the Industries. The following are additional Notes from the Official Reports which can be obtained from H.M. Stationery Office

CIOS XXXI-8.—This report deals with plastics and wooden parts in German aircraft and is based on observations at the Dornier, Messerschmitt and Heinkel plants. In order to conserve metal, several semi-structural and structural parts in wood had been developed, the most striking of which is the all-wood wing of the He-162. A new type of deicing boot, which comprised resistance wires embedded in a plastic sheath, was also of interest. A new "sealer" had been developed by I.G. Farbenindustrie and applied by Heinkel. This was Polystal, a material that has already been mentioned in these reports, a di-isocyanate resin which was used to seal the integral gas tanks in the wing of the He-162. No startling applications of moulding plastics were discovered.

CIOS XXVI-20.—This report deals with the famous Franz Clouth works at Nippes, near Cologne. The most interesting notes are on the lining of tanks with synthetic rubber. Details are as follow:

The top of the vulcanizer is provided with a number of vents to permit escape of air when steam is applied. Vulcanizers not jacketed. Below is given the procedure.

All tanks are first shot blasted, secondly three coats Buna S cement, thirdly one layer $\frac{1}{16}$-in. soft Buna S, fourthly, one layer final covering.

Covering range from 4 mm. to 8 mm. in thickness.

Fifthly, placed in vulcanizer under 90 lb. air pressure, then steam turned on. Vulcanize one hour at 136 degrees C., remove and test electrically for defects; 3 amps. 500 volts. Repair any defects, then return to vulcanizer, placed under 90 lb. air pressure and cured three to four hours more at 136 degrees C. with direct steam. Test again electrically and ship.

B10S Report No. 104. Item No. 22.—This report repeats much that has already been described by the I.G. factory at Schkopau, Bitterfeld and Wolfen. At the latter plant polyvinyl chloride was received from Bitterfeld.

The polyvinyl chloride powder and plasticizer are extruded through a nozzle at a temperature of 160 degrees C. at a speed of 30-40 ft./min. A stretch to 225 per cent. is then applied by passing through rollers. The first of these pairs of rollers run in hot water at 90 degrees C., the second at 20 degrees C. in a bath of cold water. The continuous filament is then wound between two arms carried at right angles to a bar which is rotating about its mid-point, thus producing a "hank" of filament. The looped ends are then sheared off for return to the extrusion machine after grinding, whilst the straight lengths are bundled for despatch. Alteration of nozzles gives different sizes of bristles and canes.

B10S Report No. 44.—Various synthetic fibres that Germany utilized during the war have surprised many industrial workers. Most progress has been made with Perlon, which belongs to the Nylon family, and with polyvinyl chloride fibres. Perlon was mainly used for parachutes, tyres and mixed with wool and cotton for hosiery. No fibres were made from polyvinyl chloride (56 per cent. chlorine), but the chlorinated polyvinyl chloride was produced at Wolfen by the I.G. This fibre is known as P.C. and contains 62-64 per cent. chlorine. As much as 400 metric tons were produced each month. Nevertheless, the softening point was not satisfactory and a special polyvinylidene chloride co-polymerized with vinyl acetate was made and stated to handle better than P.C. in the fibre form.

The Silicon Plastics

By E. E. HALLS

TO the student of organic chemistry, there is nothing new or novel in a number of series of homologues akin to the organic compounds having carbon as the base, but in which the element silicon appears instead of carbon. The appearance of the much-discussed "silicone" series of plastics does not, therefore, come as a surprise. They are the result of intensive and patient research to which impetus has been given by virtue of the fact that there is a need in industry, and particularly the electrical industry, for heat resistant and moisture impermeable materials of high electrical quality, and there was great confidence that such materials could be provided from such a field of study. The real surprises are contained in the facts, first, that such a large number of sound products have been established; secondly, that their commercial production has been achieved successfully, and thirdly, that these compounds have been judiciously applied in appropriate directions on a very large scale with results that justified expectations. The team work behind this effort, with co-operation between scientists and technicians for the chemical production of the silicones on the one hand, and the engineers and factory technicians for their applications into electrical (and other) equipment on the other hand, demands admiration, even if we technicians on this side of the Atlantic do feel we have been outside even the fringe of it all. It is granted, therefore, that the innovation of the silicones is, in itself, a notable advance, signifying not only new materials, but in conjunction with them, the better utilization of certain existing materials, the possibility of new electrical designs, greater efficiencies and higher outputs from existing designs, and smaller equipments with the same efficiency for the future.

Granting that a number of amazing new materials has been introduced and that these, by virtue of their remarkable and desirable properties, enable rapid advances to be made in many industries and, especially in electrical power engineering, this makes it even more necessary to take a sober view of the position, and the reasons enhancing this fact are noted below.

First, it is claimed and substantiated by successful exploitation in America, that the silicone plastics have exceptional properties of heat resistance and moisture-proofness, very good electrical properties, and that they can be produced in a range of forms, liquid, grease-like, rubbery and solid. These attractive properties need to be taken advantage of by judicious understanding and application with possibly the necessary redesign of equipment. Often these special properties preclude their adoption for use with existing plastics which satisfy specific needs; they represent something additional to materials known to industry, and not replacement materials that will largely oust the old-established products. They are an advance of which the timely arrival will enable other industries to progress.

Secondly, although the chemical reactions by which the silicones are produced are well established, they are intricate and expensive. Cost is likely to be high. Further, electrolytes are used or produced as decomposition products and these have to be removed completely if stable and highest electrical characteristics are to be obtained. This, again, reflects on cost. Therefore, although the reactions involved are simple, the extreme of process control and skill is involved in their manufacture. Further, this technique has not yet been acquired, at least to any degree, outside America.

Thirdly, the production of silicones is in its infancy, and, having mind to the

infinite possibilities, it is confined to a narrow range of products produced by a single basic process. The future from this point is uncharted, and it is useless to hazard a guess, but it is stressed that too rigid a view of their merits and demerits should not be formulated at this stage. Undoubtedly, numerous industrial research establishments are studying other reactions and, in fact, other types of silicon derivatives, and the results may add appreciably to the limited picture that can be drawn at the moment with our present knowledge.

Fourthly, while admitting that there are many applications to which some of the silicones can be placed with advantage immediately and without any real changes or modifications to existing methods, processes and designs, the major applications do involve reconsideration of existing practices; transformer and motor design are cases in point. Such alterations probably cannot be effected easily; in fact, in this country at the moment there may not be materials available in the right quality (and one has in mind here such materials as silicon-iron lamination materials as "Hypersil," glass-fibre insulated conductors of appropriate space-factor and silicone impregnated fibre-glass sheet, or fibre-glass laminated sheet). Moreover, they may be costly in plant and production layout changes, especially as our outputs have to be so much smaller than those in America. An overall increase in the cost of the product manufactured is not unlikely, and this must be borne by the customer. This is only likely to be acceptable when the customer receives some obvious advantage to offset this cost, either in terms of the space required to house the apparatus, or in its better operating efficiency, or both.

Fifthly, it must be remembered that the silicones and their applications have been established on a war-time basis, when speed of production, quantity and immediate performance have been deciding issues. Cost has not entered seriously, appearance has been of little account, and maintenance of equipment characteristics over a long term of years has had to be assessed by empirical accelerated tests or ignored completely. Peace-time assessment of value in these directions will be more exacting.

Sixthly, the claim for adhesion, waterproofness, heat resistance, electric strength, power factor and the like have all been based on American applications in which, so far as we know, equipments have been designed to take the silicones and to obtain the best from them. Our experience of materials and processes in other directions have not always coincided with those in America, and this has been due to differing modes of usage or application, method or process, or different methods of assessment by test, or again differing interpretation of results. Consequently, it is felt that a true evaluation of the silicones will only be possible when they are available here in quantity, not only for laboratory testing but also for field trials in equipments under actual conditions of service.

Lastly, it is important to avoid anything in the nature of a silicone complex and the indiscriminate application of these plastics. The requirements of the job must be such that the properties of these materials can be made use of advantageously, and the design and other materials employed must harmonize. Otherwise, a valuable material is being applied uselessly, and it may, in fact, do more harm than good.

Silicon Compounds Other than Silicones

The silicones are not the first series of organic silicon compounds to be commercialized. Their forerunners are silicon esters, which will be readily recognized, and they have found extensive application although only in a few specific fields. The simple silicon ester rapidly hydrolyses with water to the alcohol and silica, but work in recent years has shown that, by controlling the reaction, hydrolysis with polymerization to organic silicon complexes can be achieved. Useful products can thus be produced and they have found application in priority jobs during the war years. It is essential, therefore, to

include them in any comprehensive consideration of silicon plastics.

Another series of organic silicon compounds that were utilized before the silicones were exploited are the organochloro-silanes, which, when applied, hydrolyse to hydrochloric acid and a silicone. Again, these materials cannot be disregarded.

The silicones are the primary feature of this résumé but reference will be made to these other groups later.

As far as is known at present, all the work that has been done on silicones, and which represents the basis of extensive commercial applications, is of American origin. The following presentation, therefore, consists, except for the brief considerations of mode of formation, of abstracts from American literature.

Ageing of Insulators

In "Electrical Engineering," Vol. 64, No. 3, March, 1945, page 90, T. A. Kauppi and G. L. Moses deal with "Organo-Silicon Compounds for Insulating Electric Machines." This is one of the most useful and important of the electrical applications of the silicones. The authors review the general problem of electrical insulation in relation to silicone insulating materials. They discuss the chemical and physical properties of them, and deal with their thermal stability and moisture resistance compared with the same qualities of conventional insulation of the class A and B categories of the A.I.E.E.

That the ageing of insulating materials is an important factor in the life of electrical machines is an undisputed factor.

Kauppi and Moses conclude, as a consequence, that the deterioration of class B insulation is mainly determined by the bonds and varnish, rather than by the inorganic materials, which they consider have indefinite life. Arnold and Frost (1) have indicated that insulating varnish is the most important factor from the standpoint of the ageing of insulation. The A.I.E.E. standards for permissible operating limits (2) imply that they permit only a 20-degree C. increase in observable temperature for class B over class A insulation when inorganic materials such as mica, asbestos and fibre-glass are used in combination with organic resins.

References to the literature (3, 4, 5) show that from the earliest days of the development of electrical machinery, the relation between operating temperature and life of the insulation was recognized. The seriousness of this feature is shown by experimental and theoretical findings which established that in the range 135 to 200 degrees C., on class A windings, a temperature increment of 10 to 11 degrees C. reduced the time of failure to one half. Nevertheless, one feature was rather overlooked. These early considerations of the life of the insulation were based on its mechanical durability. The fact that the thermal behaviour is important in another sense, namely the effect of ageing upon moisture resistance of the insulation, was not stressed. Further, it is pointed out that "insulation life" implies that after a certain period of ageing, the useful life of the insulation is expended, i.e., there is a fairly definite end point. In the laboratory, this life value depends upon the tests or criteria for its evaluation. In service, it is determined by all operating conditions encountered. The use of very severe test conditions, or the imposition of severe operating conditions, result in the minimum life value which may only be a fraction of the life shown by less arduous conditions. Regarding the insulation varnish, one of its most important functions is to exclude moisture from the windings; the minimum life of the varnish film is a measure of the point at which a hazardous reduction in moisture resistance occurs.

It can usefully be added here that the testing of organic materials for electrical life, and assessing electrical fatigue of materials, is far more involved and difficult than similar mechanical evaluations. It is also obvious from the above that it is dangerous in test set-ups to go too far in the direction of artificial acceleration of conditions because the life revealed is disproportionately shortened. Again, from the practical angle, the average conditions alone are insufficient for

consideration; peak periods, such as overload circumstances, must be given attention and the frequency with which they occur as well as their duration. Without any adverse reflection upon designers and manufacturers, it is probably true to state that, in practice, the general tendency is to overload rather than underload electrical equipment. It is probably in this direction that the silicones, used in conjunction with the other materials of construction correctly chosen, will be most valuable. That is, they permit such an all-round better performance with respect to temperature that the additional strain imposed by overload becomes a smaller peak over the average condition.

The first silicone varnishes produced showed remarkable heat stability and water-proofness as compared to ordinary varnishes. These original resins needed to be modified to suit the needs of the electrical equipment manufacturer, as well as for applications to different types of insulation. These modifications had to be achieved without any diminution of the original thermal and moisture qualities. The development of tests for accurate evaluation of these properties was necessary.

The silicones, which resulted from researches into high polymers (7) in a field virtually intermediate between the glasses and silicates on one side and the organic plastics on the other, was further stimulated by the rapid strides made in fibrous glass insulation in the form of wire coverings, fabric, etc. The silicones soon became recognized as the natural complements to these inorganic substances, mica, glass and asbestos, for use in bonding, filling voids and generally excluding moisture. Their good wetting properties for glass-like materials further assured this application.

The statement that silicones are derived from the readily obtainable cheap raw materials, sand, brine, coal and oil, is no doubt pedantically a true one, and impresses non-technical people, but is scarcely acceptable to chemical workers.

The real starting materials are obtained from these by processes that are by no means inexpensive and which must be very closely controlled. The silicon chloride from sand, the magnesium from sea water and the organic chlorides (or other halides) from coal or petroleum hydrocarbons are reacted on the principle of the Grignard reaction to yield organosilicon chlorides. The next stage is the hydrolysis of these compounds to the equivalent hydroxyl compounds known as silanols. It is at this stage that meticulous care must be exercised to remove all traces of hydrochloric acid and magnesium salts by water washing. These are then condensed, whereby water is eliminated, and silioxanes are produced. These are the silicones, polymers in which the silicon atoms are bonded through oxygen linkages and in which the silicon-atom carries one or more hydrocarbon groupings bonded directly to itself. The complexity and immensity of the field is quickly apparent. Apart from influencing the properties of the final product by the processing conditions of the final stage, it can be influenced by the choice of organic halide first selected, whether a mono-, di- or tri- silanol is produced, or mixtures of these, or admixtures of organic groupings. All of them will have the heat resistance imparted by the silicon-oxygen linkage; all will have moisture resistant properties. Physical properties such as mobility or viscosity, liquid, grease, rubber or solid-like nature, density, etc., will be determined by the combination adopted.

Reference (8) gives more chemical details, and W. S. Penn, "Silicone Resins and Plastics," "Plastics," June, 1945, cites specific examples in detail.

The first silicone polymers in production were the liquid varieties, of which a wide variety is now available, characterized by viscosity, which, over the whole group, covers a wide range. In general, they all exhibit:—

(a) Low change in viscosity with temperature.

(b) Low freezing point.

(c) Unusual inertness.

(d) Stability to heat.

Table 1.—Properties of Dow Corning Type-500 Fluid.

Viscosity grade in centistokes at 25°C.	Boiling point		Freezing point, °C.	Flash point, °F. (min.)	Sp. gr. at 25°C./25°C.	Refractive index at 25°C.	Expansion coef., C × 10^2 per °C., 25 to 100°C.
	Temp., °C.	Pressure, mm. hg.					
0.65	99.5	760	−68	30	0.7606	1.3748	1.598
1.0	152	760	−86	100	0.8182	1.3822	1.451
1.5	192	760	−76	160	0.8516	1.3872	1.312
2.0	230	760	−84	195	0.8710	1.3902	1.247
3.0	70–100	0.5	−70	225	0.896	1.394	1.170
5.0	120–160	0.5	−70	270	0.918	1.397	1.095
10.0	>200	0.5	−67	350	0.940	1.399	1.035
20.0	>200	0.5	−60	520	0.950	1.400	1.025
50.0	>250	0.5	−55	540	0.955	1.402	1.000
100.0	>250	0.5	−55	600	0.966	1.403	0.994

Practical applications are for gauge liquids, damping fluids and hydraulic media. In dilute solution, they are used for coating ceramic surfaces to render them water repellent.

Two groups of liquid silicones have been classified, based on viscosity range and service temperature to be satisfied. Table 1 lists the liquid silicones for use down to − 55 degrees C. and below, these being one particular type and covering viscosity grades up to 100 centistokes. Those above 20 centistokes are non-volatile and provide useful dielectrics; their temperature coefficient of viscosity is very low.

Table 2 lists a second type of liquid silicone for use down to −40 degrees C. and up to 200 degrees C., and these cover viscosity grades from 100 centistokes upwards. They are all non-volatile dielectrics with even lower viscosity/temperature coefficients than the liquids referred to in Table 1. The materials covered by both tables are characterized by their heat stability, general inertness and resistance to oxidation. Also, they are non-corrosive to metals and non-solvents for rubber, synthetics and other organic plastics. Their flash points are considerably higher than those of the petroleum oils of equivalent viscosity, but they will burn once they are ignited, yielding silica, carbon di-oxide and water. Their surface tension is low, being of the order of 20 dynes/sq. cm., and they readily wet clean dry surfaces of glass, ceramics and metals, rendering them water-repellent. They are both insoluble in, and unaffected by, water, and unaffected by dilute acids or salt solutions. They are soluble in most organic solvents, including carbon tetrachloride and the aromatic naphthas, but insoluble in alcohol and acetone.

The non-volatile types of these silicone liquids have dielectric constants from 2.7 to 2.8 at room temperature, dependent upon the viscosity grade. The dielectric constant decreases with temperature rise, and the change is about that to be anticipated from the expansional data in Tables 1 and 2. It changes very little with temperature as is shown by the data in Table 3. This also shows that power factor is unusually low, being less than 0.0001 at ordinary frequencies, and not increasing apparently up to frequencies of 10^7 and 10^8 cycles. At still higher frequencies, the power factor does show more rapid rise. It increases with temperature, but remains lower than that for a typical transformer oil. Dielectric

Table 2.—Properties of Dow Corning Type-200 Fluid.

Flash point, °F. (min.)	Refractive index at 25°C.	Expansion coef., C × 10^2 per °C.		Viscosity in centistokes at		
		−25 to 0	25 to 100	−40°F.	100°F.	210°F.
600	1.4030	0.926	0.969	650	82	32
615	1.4031	0.921	0.968	1,300	160	65
625	1.4032	0.917	0.966	1,950	260	135
625	1.4033	0.909	0.965	3,300	370	190
640	1.4035	0.900	0.963	6,500	735	260

strength at 60 cycles is 250-300 volts./mil. at 100 mils. Volume resistivity is of the order of 10^{14} and does not fall below 10^{12} at 200 C. The low dissipation factors of these liquid silicones at elevated temperatures or at high frequencies, and their inertness to moisture, suggests an application in liquid-filled condensers.

With respect to silicone greases, Kauppi and Moses report a translucent product having a consistency like that of petroleum jelly, developed for use as a lubricant for ignition cables. Its object is to reduce corona cutting of the insulation and to permit the easy wiring of ignition harnesses.

This silicone grease is stable to heat and retains its soft, grease-like consistency from − 40 to + 200 degrees C. Despite its soft and grease-like appearance, it does not melt upon exposure to heat, and it is inert and resistant to oxidation. It possesses the advantage of having no solvent action upon synthetic insulations or upon rubber. Further, it prevents the hardening of these materials when heated in contact with air.

Table 3.—Dielectric Properties of Typical Dow Corning Silicone Fluids

(At 25° C. and 50 Per Cent. Relative Humidity)

Frequency, Cycles	3 Centistokes, Type 500		350 Centistokes, Type 200	
	Dielectric constant	Power factor	Dielectric constant	Power factor
10^2	2.412	<0.0001	2.74	<0.0001
10^3	2.41	<0.0001	2.73	<0.0001
10^6	2.405	<0.0002	2.72	<0.0002
10^7	2.40	0.0002	2.71	0.0002
10^8	2.39	0.0002	2.70	0.0006

Other silicone greases are used for the lubrication of ball and roller bearings. One of these can be used at − 50 degrees C., and at the same time possesses high temperature stability at least as good as that of the best available organic greases.

Silicone resinous products cover two types, an insulating varnish variety comparable with the organic oleo-resinous varnishes in physical properties, and a variety corresponding in general behaviour to the organic thermosetting resins.

The available varnish types of silicone resins require baking temperatures of 200-250 degrees C., and heat of this order, of course, prohibits the use of organic insulants in conjunction with them. Where the organic varnishes are used to coat cotton, silk, paper, wood and the like, the silicone varnishes must be used in conjunction with inorganic insulants including glass fibre, asbestos, mica and ceramics. The silicone varnish is thus the natural material to select for coating glass fibre covered instrument wire, for the production of impregnated fibre glass cloth, and it is also used for built-up flexible mica-glass laminated sheet. It is used, too, as the impregnating and the coating varnish of machines, to bind the components together and to render the complete assembly waterproof.

The other variety of silicone resin is used where rigidity is required. Thus it is employed in the production of laminated by bonding fibre glass, and asbestos sheet, and for the impregnation of coils in which hardness and rigidity are specifically required.

It is thus seen that these silicone resins enable machines that contain no organic material to be constructed. By this means, it is stated that the thermal limitations of the complete insulation may be raised to such an extent that thermal ageing of the insulation can be ignored in design. Hence, if silicone insulation is adopted, factors other than insulation ageing establish the operating temperatures.

The thermal endurance of silicone resins has been compared with that of the organic resins by numerous laboratory tests. Flexing life of films on metal panels is the commonest test method. The procedure of the ASTM heat endurance test for varnishes (9), is used, but with elevated temperatures. Tests are reported on resin films of thickness 0.002 in. on aluminium panels 0.005 in. thickness, a film being applied to both sides of the metal. After ageing at temperature, the panels are assessed by bending around a mandrel, $\frac{1}{8}$-in. diameter being the standard.

Fig. 1 records the result of a series of tests for flexibility life for a silicone

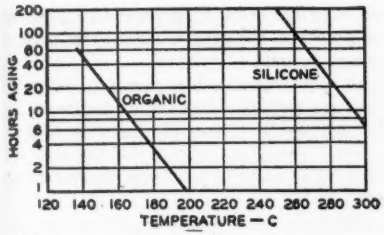

Fig. 1.—Comparison of heat endurance of organic and silicone varnishes.

resin and for one of the better varnishes of organic synthetic resin, phenolic alkyd type. The curves show flexing life for a range of temperatures. These place the thermal endurance of the two types into two groups well apart, and establish the superiority of the silicone material.

Kauppi and Moses consider it significant that the tests indicate that the life follows the general law of Montsinger (5) because, if it can be proved that the insulation on apparatus follows the same law over a wide spread of temperature, this would permit of the extrapolation of highly accelerated thermal ageing test data.

A.C. stator coils show results comparable with those obtained on materials or on varnish films. In a typical series of tests, standard class B insulated stator coils, and similar items with silicone insulation, are compared. These coils use glass insulated wire, glass-backed mica wrapper on the slot section, glass-backed mica tape on the diamonds, and glass tape for the overall lapping. The results of such a series of tests are shown in Fig. 2. In these, the moisture resistance of the two groups of coils is compared during ageing at 200 degrees C. in air. The initial values for insulation resistance, and those after ageing, were measured with the coils half-immersed in tap water for one hour. A 500-volt D.C. megohm bridge was used, and the actual reading taken one minute after application of the voltage. The difference in initial readings shows the superior moisture resistance of the silicone resins, and the path of the curves proves the superior thermal endurance of the silcone resins. The ordinary insulation used high-grade phenolic-alkyd resins.

Actual operating conditions are the final test for superiority of the silicone varnishes. To this end, it is necessary to conduct field tests on complete apparatus or equipment in parallel with the laboratory tests. Service conditions must be simulated as closely as possible, and the tests should be conducted at several temperatures in order to obtain some information upon the temperature slope of the thermal endurance. For this purpose, the engineers of a number of American companies have agreed upon test procedures for the appraisal of the insulation characteristics of motors having high temperature silicone insulation. The moisture-proofness of the insulation is the basis of these tests. The windings are exposed to humidity, usually for a period of 24 hours, to determine their resistance to moisture initially and after some degree of accelerated ageing or

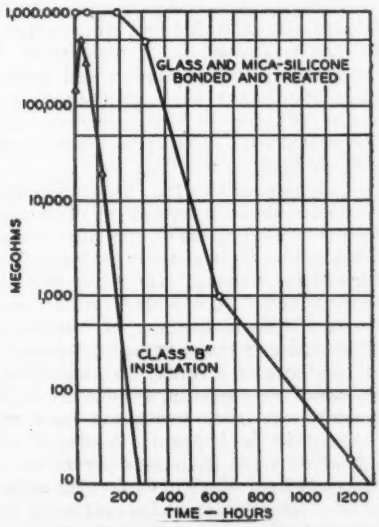

Fig. 2.—Moisture resistance tests on class B and silicone-treated insulations on A.C. generator coils during ageing at 200 deg. C.

other damaging test. The test equipment and procedure are as follow:—

The apparatus to be tested is enclosed in the high humidity cabinet, which has a sloping roof so arranged that condensed water does not drip on to the winding. The sides of the cabinet are thermally insulated, but the top is not. The humidity is produced from an open tray of water within the cabinet, the water being heated electrically. By maintaining the water temperature from 5 to 10 degrees C. above the air temperature of the cabinet, 100 per cent. relative humidity is obtained. It is arranged that the water vapour concentration is such that the condensation to form streams or puddles of water on the insulation is avoided. An ambient temperature in the room in which the test set-up is housed of 25 to 30 degrees C. is preferred. When the design of apparatus under test does not permit of free air circulation, an end bracket is removed to give free access of the humidified air to all parts of the winding.

The first test procedure is to humidify for 24 hours and then measure insulation resistance between winding and frame. Immediately following this, a high potential test is applied for 5 mins., using a test voltage between winding and frame identical with the rated line-to-line voltage of the machine. Finally, the machine is operated for 5 mins. at normal voltage with no load.

A recommended test for damaging thermal endurance consists in operating motors at 240 degrees C., the latter being measured by readings taken on the resistance of the winding. The motor should be shut down once a day for thermal cycling. Also, at intervals of 200 hours of operating at the elevated temperature, the sequence of humidity test, insulation resistance measurement, five-minute high potential test and five-minute no-load run, should be imposed. Again, when similar tests are made at different temperatures from which to explore the slope of the temperature/ageing curve, it is advocated that the length of the running period between humidity tests be halved for each 12 degrees C. increase, or doubled for each 12 degrees C. decrease in observed temperature from resistance measurements.

At the time of the paper, a number of tests on motors along these lines were in hand to evaluate the serviceability of this type of insulation in a rapid manner, yet keeping as close to practical conditions as possible.

Kauppi and Moses concluded by stressing that the use of silicone resins in electrical insulation do not represent any radical departure from well-established practices. The inorganic components for high temperature insulation have long been known and their characteristics proved. It was the organic bonds, impregnants and surface treatments that limited the thermal endurance of composite insulation containing mica, fibre glass and asbestos. The substitution of silicone resins for all the organic resins in these materials is the implication. It is to be noted that the substitution of the inorganic materials is not suggested. They also emphasize that both innumerable laboratory tests and 50 years of experience in the field have demonstrated that thermal ageing is the most important single factor in insulation life. They assert that it is only after thermal ageing has occurred that good insulation becomes " vulnerable to the other ills that plague it." Further, the differences in thermal endurance of various types of insulation have been clearly established to be a function of the stability of the essential components of the insulation. In consequence, the individual contribution due to the good thermal properties of the silicones promises much for the future. There is no point in increasing the operating temperature unless some useful economic purpose is served, but where electrical machines must operate hot, or where failure from thermal endurance occurs, there are the fields for the silicones. A re-examination of the thermal endurance requirements for insulation of electrical apparatus, an examination of the possible advantages from the more heat resistant silicones, and development of means of using them where justified;

these are problems to be tackled by as many engineers as possible to obtain the broadest perspective in the quickest time.

Under the title of "The Application of Silicone Resins to Insulation for Electric Machinery," J. De Kiep, L. R. Hill and G. L. Moses, in the same issue of "Electrical Engineering," March, 1945, p. 94, deal with experience in the application of silicone resins, laboratory tests on materials and coils, and laboratory tests on rotating apparatus. Practical aspects are discussed, and recommendations are made for obtaining an adequate high temperature insulation. Thermal ageing tests are given and recommendations made for tentative limits on temperature for general rating and application purposes. The salient features will be extracted below from this paper.

The authors indicate that designers can utilize the excellent temperature resistance when permitted by A.I.E.E. Standards in three important ways, viz.:—

(1) To reduce size and weight of some apparatus through increase in operating temperature.

(2) To permit operating under high ambient temperatures.

(3) To obtain increased insulation service life or reliability where it is desired to maintain conventional size, weight and temperature.

A simple test is cited and illustrated. It consists in dipping a piece of fibre glass cloth in conventional organic varnish, and another piece in a silicone insulating varnish, and then to place the two specimens in an oven at some elevated temperature for a definite period of time. The organic varnish is a phenolic-alkyd varnish used for the treatment of class B apparatus. The silicone varnish was Dow Corning 993. They were aged at 250 degrees C. In the unaged condition, there was little difference in mechanical properties between the two samples of treated cloth. Insulating properties were good, they were not seriously affected by immersion in transformer oil, and they were moisture resistant. After only 2 hours' ageing the organic varnished sample was seriously affected. After 20 hours' ageing it had completely deteriorated and under no circumstances could be considered as a dielectric material. The silicone treated material in 20 hours' ageing underwent no observable deterioration.

The A.S.T.M. flexing life test, or heat endurance test, is used for more quantitative information. The copper panel stipulated in the test is unsatisfactory, as

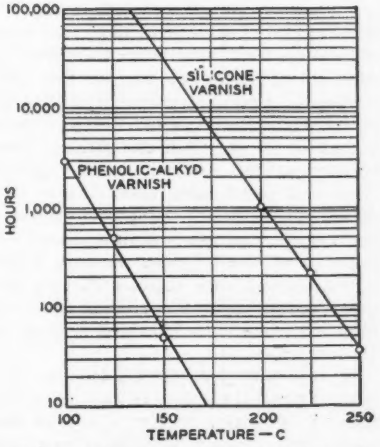

Fig. 3. — Comparison by elongation of silicone varnish film 0.002-inch thick and organic varnish film 0.002-inch thick after thermal ageing.

copper is prone to rapid oxidation. Cadmium-plated copper or aluminium is recommended. Fig. 3 records detailed results on a conventional phenolic-alkyd organic varnish and on one of the silicone varnishes. The flexing life tests do not indicate the point at which varnish films would fail on an electric machine, but they are useful for comparing the relative order of magnitude of heat endurance. The end point of the test corresponds roughly to a 14 per cent. elongation of the film. The rate at which the maximum elongation for failure changes with time and temperature is

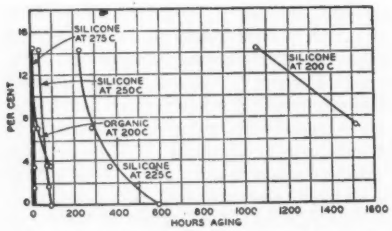

Fig. 4.—Comparison of flexing life of 0.002-inch thick films of organic resin and silicone varnishes on copper panels aged at various temperatures.

informative. Fig. 4 gives the percentage elongation for failure plotted against the number of hours of ageing. At 200 degrees C. a good phenolic-alkyd varnish will last about two hours before failure occurs at 14 per cent. elongation. One silicone varnish under the same conditions will last about 1,000 hours. At 200 degrees C. and 7 per cent. elongation, the organic varnish will last about 40 hours and the silicone varnish 1,500 hours. These data indicate that at the same temperature the silicone varnish may last from 40 to 500 times as long as an organic varnish.

A very sensitive test quoted for the relative thermal stability of two materials consists in coating copper wire with the resins and making elongation tests at periodic intervals after ageing at an elevated temperature. Fig. 5 gives such a detailed comparison for wire enamelled with an oleo-resin type of organic varnish and for one with a silicone varnish insulating coating. At 150 degrees C. the silicone enamelled wire was aged for 6,964 hours before it failed at an elongation of 9 per cent., whereas the synthetic oleo-resin varnished wire failed at an elongation of 9 per cent. in 240 hours. At 200 degrees C. and 3 per cent. elongation, the silicone-insulated wire failed only after 216 hours and the organic-varnished wire failed after two hours.

From a critical analysis of much such data, the authors conclude that silicone varnishes will protect apparatus for 20 to 100 times as long as organic varnishes at the same temperature. Alternatively, operating temperatures may be raised from 50 to 75 degrees C. when these resins are used.

Using the silicone resins for bonding, impregnating, coating and the like, process conditions involve the high temperature range of 200 to 250 degrees C. for curing, but treatment times are of the same order as those involved for the orthodox varnishes. This is the position to-day, but, with much research yet to be done, more favourable conditions from the practical aspect may result.

Heat, vibration and expansion tests have also been made. For example, such tests were conducted on armature coils having three different types of class B insulation in comparison with the high-temperature type of silicone resin insulation. The armatures for test were wound into cores and subjected to severe vibration and thermal cycling in combination with accelerated thermal ageing. Typical D.C. generator armature coils were used, and each coil consisted of two single coils per slot composed of four strands of 0.114 by 0.229-in. copper ribbon. All groups had mica ground insulation, but Nos. 2 and 4 used glass-backed mica. Groups 1 and 3 were

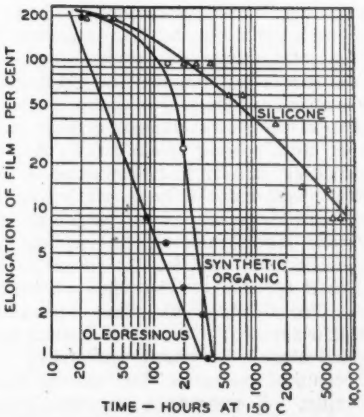

Fig. 5.—Elongation failure versus time for resin films on number 18 copper wire.

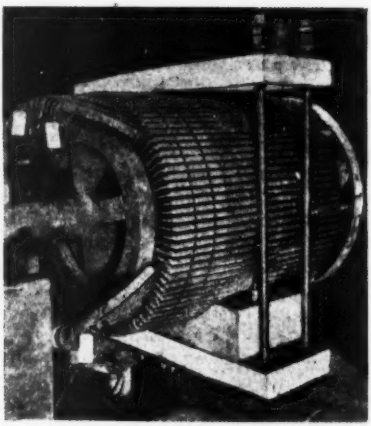

Fig. 6.—Test set-up for severe thermal ageing, thermal cycling, and vibration test.

finished with asbestos tape and were treated with a high-grade organic thermosetting varnish, and groups 2 and 4 with glass tape. Groups 1, 2 and 3 were treated with organic thermosetting varnish and group 4 with silicone varnish. There were nine coils from each group wound in a core as shown in Fig. 6. Severe vibration was produced by means of a fractional horse-power high-speed motor operated on an unbalanced flywheel. All the coils were connected in series and energized through a cycle drum and a timer so that the coils were heated for 12 minutes and cooled by a blower for 18 minutes. The test ran 16 hours a day for 36 days, during which the coil temperatures were between 209 and 230 degrees C. The asbestos finishing tape in Groups 1 and 3 showed serious thermal deterioration, and the glass tape in Group 2 became hard and brittle, while the glass finishing tape of Group 4 (silicone varnished) was still soft and flexible. Mica treated with silicone resin retained more flexibility than the class B mica insulation. The glass-covered conductor insulation was in usable condition on both Groups 2 and 4, but the insulation on the wire with silicone treatment had better flexibility than that treated with organic resin.

The first motor to be successfully treated with silicone resins is believed to be a totally enclosed fan-cooled induction motor, on which tests were started in April, 1942. It was designed for 10 h.p., 3-phase, 60 cycles, 440 volts, 4 poles, 1,690 r.p.m. The insulation was the best available class B material, using glass and mica, and the finished winding was treated with silicone varnish; the composite insulating materials, for example, of glass fibre and silicone varnish, were not available at that date.

The tests made on this silicone resin-impregnated motor were comprehensive and thorough, as can be seen from the following summary:—

(1) Complete engineering tests, including full-load temperature run at rated horse-power (100 degrees C. rise by thermocouples).

(2) The motor was overloaded, the temperature reaching 416 degrees C. in 1½ hours.

(3) The load was reduced until the temperature stabilized at 300 degrees C.

(4) The motor was heavily overloaded for a period of 45 mins., the temperature of the winding reaching 516 degrees C.

(5) After the tests covered by 1 to 4, the motor was re-treated, and then given a thermal endurance test at a load producing 200 degrees C. rise, as shown by resistance measurement. This test continued for 3,376 hours at an estimated hot-spot temperature of approximately 250 degrees C.

(6) Periodically the motor was dismantled for examination, and exposed to high humidity and various insulation tests.

Some detail is necessary to show the performance results under this test schedule. After 920 hours of thermal endurance test, the silicone varnish treatment was in generally good condition.

The windings withstood high potential and high-frequency tests at 2,000 volts, insulation resistance tests and high potential tests after exposure to humidity without failure. After a severe humidity test with end bells removed, the insulation resistance was reduced but was still adequate for operation.

The motor was again examined and given humidity and insulation resistance tests after 2,250 hours of ageing. The silicone varnish was reasonably good although showing slight signs of deterioration. After 3,376 hours of operating on accelerated ageing, bearing failure caused the rotor to stall. The rotor conductors melted and flowed over the windings, but the silicone varnish and insulation were in approximately the same condition as at the time of the previous examination. It was confirmed without doubt that the bearing was the cause of failure and that the winding and insulation were suitable for further operation. The motor was stripped, and the resin found to be brittle and to powder as the winding was stripped; in some places, the glass tape in the end windings broke easily. Loosening of the glass was more frequent in the end windings than in the slots, but glass-backed mica cells were still solid and flexible to a considerable degree. In most places, the glass wire covering still retained adhesion to the conductors. It is pointed out that, in this first silicone-treated motor, other resins and bonds were used, the silicone varnish being only employed for the final treatments.

The tests by thermal ageing on a medium-size three-phase generator are also dealt with by De Kiep, Hill and Moses. The stator winding was completely insulated with high temperature silicone insulation. Thus silicone resins were used for the treatment of the glass-covered wire, for bonding the mica, for the treatment of the glass cloth and tape, impregnation of the coils, and surface dipping of the wound stator. All ground insulation was glass-backed mica wrapper or tape. Treated glass was only used as a separator or binder. Slot wedges were of best grade phenolic resin bonded asbestos laminate together with a few made of phenolic resin bonded glass cloth.

First, a water-spray test was applied for 48 hours to check the moisture resistance of the winding. The insulation resistance fell from 28,000 megohms to 2,600 megohms.

The thermal ageing tests on the stator were applied with the generator driven at normal speed with the stator winding short-circuited. The field current was adjusted to produce a stator current of 2½ times normal. The resulting temperature rise, assessed by resistance measurement, was approximately 210 degrees C. Thermal cycling was attained by operating the stator on short circuit on alternate days only; on other days, the stator was on open circuit with the field over-excited. The result of this was the generation of 40 per cent. above normal voltage in the stator winding, producing the effect of over-potential test on turn and ground insulation. This also caused thermal cycling on these windings on these alternate days.

The following are representative temperatures in degrees Centigrade on the stator:—

Ambient air temperature	25
Winding rise (by resistance measurement)..	211
Core rise (by thermometer reading).. ..	94
Frame rise (by thermometer reading) ..	42
Outgoing air rise (by thermometer reading)	69

The machine was examined periodically during the thermal ageing test. The ageing of the outer varnish film, as judged visually, was very slight during the whole test. The machine was operated with the stator winding conditions as described above for a total of 2,996 hours. Based on the 211 degrees C. rise with 25 degrees C. ambient temperature, and a 15 degrees C. hot spot allowance, this means approximately 250 degrees C. hot spot temperature. At the end of this thermal ageing test the winding was humidified, this being done by maintaining exposed surfaces of water, heated above the ambient temperature in an enclosure. The generator was covered with a double thickness of waterproof paper and a tarpaulin. Water in this enclosure was evaporated at a rate of

approximately ¾ gallon per 24 hours. Measured insulation values were as under:—

Time period of humidification	Stator winding resistance, megohms, 1 min. values
0	4,900
3 days	2,800
16 days	1,300
19 days	380

Final tests were made on the stator winding immediately after the humidification, without any drying-out, as under:—

(1) High potential test to ground at 1.4 times the rated voltage, 60 cycles, for five minutes.

(2) Operation open circuited at normal speed with maximum field excitation (40 per cent. over-voltage) for one hour.

(3) Short circuit applied to stator terminals with field excitation set for normal open-circuit voltage. Applied for two minutes with no evidence of loosening of the winding.

(4) Insulation resistance measured, 10,200 megohms; dissipation factor, 3.2 per cent.

(5) Intentional destruction by high potential test without drying out of the winding. It held 1,000 volts and failed at 1,600 volts in 12 seconds. The operating rating was 440 volts A.C.

Numerous totally enclosed fan-cooled induction motors have been made using the high-temperature silicone insulation, and operated at high temperatures. None of them yet reveals any marked deterioration of insulation resistance, and high potential tests have shown no breakdowns. The motors from 2 to 25 h.p. shown in Table No. 4, which gives operating temperature and hours of test (to the date of this paper) are still functioning satisfactorily.

These data all confirm that the silicone varnishes and bonded inorganic materials enable much higher operating temperatures to be achieved than hitherto. Other design features must not be overlooked. Larger airgaps to allow for the greater expansion of the rotor, bearing allowances for greater expansion of the shafting, and bearings and lubricants to withstand these higher temperatures, must all be considered.

Regarding lubricants for satisfying the conditions of higher operating temperatures, the previous paper by Kauppi and Moses showed that silicone oils and greases would meet the case. They possess the same advantages over the conventional organic oils and greases as the silicone varnishes do over the organic varnishes. Tests on motors have shown that the better grades of organic lubricants cannot be operated for extended periods of time above 90 degrees C. The indications to date are that silicone greases function satisfactorily about 50 degrees C. beyond this limit. Extensive tests are in hand in this direction.

Finally, DeKiep, Hill and Moses review design factors, which indicates that they do not recommend silicone compositions when their advantages cannot be utilized, and that in other cases design must be adjusted to secure overall advantages. They point out that on open, splashproof and semi-enclosed motors in which performance of the motor rather than temperature determines the amount of material used, the use of high-temperature insulation gives no advantage. Such factors as pull-out torque, starting torque and starting current, efficiency, and power factor, determine the size of motors, and in general it is found that requirements are met using class B insulation. The silicones will be useful on

Table 4

Motor (h.p.)	Winding temperature	(Deg. C) hours
2	170	3,486
2	165	3,486
4	140	3,996
4	160	3,996
7½	320	1,907
7½	320	1,907
15	185	3,506
15	170	3,506
25	160	3,291
25	135	3,291
6	285	4,500
10	250	3,400
10	250	3,400
25	240	3,300
10	200	5,200
10	185	3,200

totally enclosed motors, and totally enclosed fan-cooled motors. For true high-temperature motors, for the maximum utilization of the material they contain, it is necessary to change the relation of copper to iron, the quality of the iron, length of air gap, and so forth.

Apparently, considerable discussion of some of the limitations of the silicones has arisen in America. Mechanical fragility, low abrasion resistance, and poor oil and solvent resistance have all been aired in this way. Some of the earlier products had shortcomings in these directions, and were inferior in some respects to organic resins. Much advance has been made, but in any case it must be remembered that a wide range is available, and proper selection must be made. A fundamental fact, however, cannot be overlooked, namely, that essential silicone characteristic of high thermal stability goes hand in hand with an inherent property of difficulty in curing. Full physical qualities, such as resistance to abrasion, cannot be expected without proper processing to achieve full curing. Precautions must be taken at every stage of the manufacturing process to ensure that best conditions and controls are used to promote the development of the essential physical and chemical characteristics of the silicone resins. The high curing range of 200 to 250 degrees C. made it necessary to ensure that composite insulation contains little or no organic materials. Bonding materials must be of silicone base as well as the impregnating and coating media. Cellulosic material must be eliminated. Prior to impregnating in silicone resin, the coil or equipment must be thoroughly baked out at a temperature at least equal to the final curing temperature in order to drive out all moisture and gases such as might be produced by decomposition of traces of cellulose or other impurities.

The authors stress that much has yet to be learned on the silicones, and that they should be reserved for specific proved applications so that development can be carried out in an orderly and progressive manner.

(To be continued)

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Patterned Acrylics

The development of a new process for producing shatter-resistant sheets of "Lucite" acrylic resin with surface patterns is announced by Du Pont de Nemours. Specially suitable applications for "Lucite" are public street lamps, ticket windows and office partitions, the company suggests. These transparent sheets are "exceptionally promising for a wide variety of decorative and utility purposes, ranging from washroom windows to edgelighted panels for hotels and night clubs," adds the announcement.

The product will be publicly displayed for the first time at the National Plastics Exhibition in New York on April 22-27.

World's Industry Employs Plastics

GENERAL ENGINEERING

The new friction-welding method for thermoplastics developed by the Rochester Button Co., U.S.A., is described in "Materials and Methods," 1945/**23**/1728. **Under the name Ferobestos, is being manufactured a new laminated plastic** described in "Engineering Materials," 1945/**3**/202. This is composed of asbestos with additions of certain other materials bonded with a special thermosetting resin. **Machining of laminated plastics** follows in general much along the lines of processes employed for metals. Notable divergencies in practice do, however, exist, and these are discussed in "Mechanical World," 1946/**119**/229. **Behaviour of plastics under extreme conditions of climate** is discussed in "Engineering Materials," 1945/**3**/228. The effects of extremes of temperature, humidity and insulation together with hazards of insect and fungoid attack are particularly referred to. **Welding, bonding and moulding of plastics** is said to be speeded by a new method described in "Scientific American," 1946/**174**/20. Protective coatings based on plastic resins form the subject of a review in "Product Engineering," 1946/**17**/1. The use, limitations and future possibilities of the materials in this connection are fully analysed. **Easily stripped plastic coating** as protection against corrosion, rough handling, is provided by a product of Eronel Industries. The material employed is the recently introduced Eronel product, "Thermodip." ("Machine Design," 1946/**18**/168.) **Plastic mouldings and zinc-alloy die castings** are discussed in relationship to general application and mechanical properties in a technical publication issued by the Zinc Alloy Die Casters Association, and reviewed in "Engineering Materials," 1945/**3**/246. **Sealing of magnesium-alloy castings** is said to be carried out with great efficacy by the use of a new plastic substitute for tung oil. The new material is a product of the Monsanto Chemical Co., Plastics Division. ("Machinery," New York, 1945/**52**/174.) **Utility of Plastics to the engineer** forms the subject of an account in Inst. Prod. Eng. Jour., 1945/**24**/340. The account deals chiefly with laminated plastics, their manufacture, properties, grades, future and typical present applications. **Oxide surface contamination from optical instrument parts** is removed by the use of a blast of plastic pellets in Tenite. ("Instrument Maker," 1946/**14**/34.) **Small plastic bearings using phenol-cresole textile laminates** were experimented with in Switzerland during the war as substitutes for the normal type of white metal and bronze bearing. Results obtained are discussed in a recent issue of Schweizer Archiv abstracted in "Machinist," 1946/**89**/2637. **Machining data on plastics,** in particular those concerning drilling tests, are discussed in "Machinist," 1946/**89**/188. In connection with drilling the difficulties of manual operation are considered along with the advantages of mechanical feeds, chipping tests and air blasting are also referred to. **Forming process for laminated phenolic sheet** in the finished cured state is described in an illustrated account in "Mechanical World," 1946/**119**/85. **Survey of recent literature on silicons** is given in "Mechanical Engineer," 1945/**68**/38. Details of polymerization processing of these materials and their use in varnishes, plastics, rubbers, greases, and liquid lubricants,

are provided. **Optical glass substitutes** are considered in "The Instrument Maker," 1945/**13**/22, from the standpoint of their technical suitability and processes. The report is based on investigations by the National Defence Research Committee, Harvard University, and the Polaroid Corporation. Cellular plastic heat insulators form the subject of a paper by M. J. Hickman (N.P.L.), read before a meeting of the Institute of Refrigeration, on March 21. The author discusses modes of heat transfer through a cellular-type heat insulator and presents data for the thermal conductivity of a number of cellular plastics in sheet form tested in a guarded electrical hot-plate apparatus. Cellular p.v.c., P.F., cresol formaldehyde, polystyrene and chlorinated rubber, were examined and compared for heat conductivity to cellular concrete, glass, rubber and calcium alginate foam. Values for the cellular plastics range from 0.24-0.31 B.T.U./sq. ft./hr./in./°F.

ELECTRICAL

All-plastic battery container weighing less than 10 lb. has been designed for housing a 12-volt battery. The transparent Lucite polymethylmethacrylate resin gives a 20 per cent. reduction in weight compared with competitive materials, such as, rubber and aluminium, and is extremely shock resistant. "Automotive and Aviation Industries," 1945/**93**/46. **Wireless receiving sets embodying plastic components** for various parts of the assembly form a very high percentage of the total output of these articles. This fact is commented on in "Scientific American," 1946/**174**/56. **Electro-deposition of vinyl plastics** and the electro-deposition of metals on plastics form the subjects of two papers recently published by the Electrochemical Society (respectively preprint 88-6 and preprint 88-5). **Metal-powder-loaded** plastics have been made the subject of sporadic investigation in this country for some years past. It appears, however, that during the war there was developed in Germany, an iron powder-loaded p.v.c., which, in the form of ribbon 0.003 in. thick, was employed for continuous strip recording and sound reproduction. The metal-loaded plastic here replaced the Swedish iron strip normally used for the Blattner phone. As opposed to the continuous metallic ribbon which caused some trouble due to hysteresis effects, the metal-loaded p.v.c. in a similar manner to powder cores for transformers, exhibited these defects to a much lesser extent. The general principle of operation with the p.v.c. ribbon is exactly similar to that for the normal iron tape. It is probable that the loading powder used is of carbonile origin.

AIRCRAFT

Transparent plastic wing tip used on more than 2,000 A-20 type aircraft is described from the historical standpoint by Krieger, of the Douglas Aircraft Co. ("Production Engineering and Management," 1945/**16**/112.) The plastic used in this connection replaces duralumin and saves servicing time as well as facilitating assembly. **Use of high-strength plastics in future aircraft design** is considered in "Mechanical Engineering," 1946/**68**/225. The technical and economic advantages of low-pressure moulded plastic structures are especially considered. **The use of cellulose plastics** in aircraft manufacture is noted in "Mechanical Engineering," 1946/**68**/233. On page 253 of the same issue reference is made to the use of **plastic models for instruction at an army ordnance school in U.S.A.** Special comment is made on the durability of the models and on the advantages gained from their absolute transparency.

MOTORS

Importance and application of glue in the automotive field are reviewed in a short account by Swealt in "Automotive and Aviation Industries," 1945/**93**/25. **Transparent plastic windows for automobiles,** a possibility discussed for some time past at great length in various technical journals, forms the subject of a short note in "Scientific American," 1946/**174**/73. It may be as well to recall that celluloid was one of the earliest materials of this group employed for such a purpose.

MISCELLANEOUS

New plastics, their properties and application, are dealt with in a "Review for 1945" published in "Materials and Methods," 1946/**23**/96. In particular, the account notes improvements effected during the past 12 months. Developmental trends in plastics, especially with respect to improvements in existing materials, machines and methods, are discussed by the Technical Director of Plastics, the Industries Technical Institute, in "The Engineers' Digest," 1946/**7**/47. **Dressings for severe wounds have been successfully produced in Nylon** and related plastics, large quantities of which have been used for the purpose. ("Scientific American," 1946/**174**/56.) Mirror frames and other mass-produced items in the lower-price ranges are now being manufactured in U.S.A. from plastic materials as indicated in the issue of "Scientific American" cited above. Plastic wrist compass developed by De Page Plastic Co., U.S.A., is referred to in "Scientific American," 1946/**174**/22, together with 17 different types of plastic dishes introduced by Devine Foods Inc., U.S.A. **Lenses, flats, mirrors and filters manufactured of synthetic resins** form the subject of an account in "Rev. Opt. Theor. Instrum.," 1941/**20**/25. Relationship between the employment of the materials for this purpose and other optical and physical mechanical properties is considered. Relationship between the **actual content of sulphur in synthetic rubbers** and the sulphur content theoretically necessary has been made the subject of experiments in U.S.A., according to an account in "Bell Laboratory Record," 1946/**14**/106. **General uses of Perspex,** its application for the manufacture of fighter hoods, light shades, casing of machinery, etc., is discussed in "Machinery Lloyd," 1946/**18**/82. The use of this transparent plastic for window display purposes in conjunction with aluminium is described at length in "Light Metals," 1946/**9**/104. **Production of synthetic rubber and plastics** is included in the technical development section of the Russian five-year plan, according to a note in "Mechanical World," 1946/**119**/375. **Facilities for the moulding of both rubber and plastic** constitute a desirable combination from the economic and technical standpoints, according to an account in "Machinist," 1946/**89**/178. **Plasticity is made the subject of a scientific definition** in a letter to "Nature," 1946/**157**/447. The definition suggested is "the property which enables a material to be deformed continuously and permanently during the application of a force that exceeds the yield value of the material." **Third edition of the A.S.T.M. standard on plastics** sponsored by a special committee of the A.S.T.M. deals with testing methods, nomenclature, definitions and specifications referring to plastic materials. **Czech chemical industry** will regain its pre-war level of operations in about six months' time. Meanwhile, the chemical works Hradec Kralove have begun production of a new synthetic resin, "Super - Acryl," particularly required for dental work and hitherto imported from the U.S.

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes

BEETLE CEMENT POWDERED.—The most recent extension of these by now famous series of wood cements is that of the powdered variety known as Beetle Cement W.3.

Stored in a dry, cool place, this powder has a shelf life estimated as up to two years. Beetle Cement W.3 is reconstituted before use by the addition of 6 parts of water to 10 parts by weight of the powder, and it then has in application the same properties and uses as the standard Beetle Cement W.2 liquid. If desired, up to 20 per cent. by weight of an extender such as rye-flour or wheat-flour may be employed to cheapen the cost of the glue line without affecting its strength or adhesion. To bring about controlled condensation or setting, hardeners must be used, and these may be selected for close contact or constructional (gap-filling) work at varying temperatures and speeds of cure. For export purposes, the hardeners too are, where practicable, supplied as solids; the gap-filling hardeners are mixed with the cement in their dry form; the close contact hardeners need to be reconstituted before use with water or industrial ethyl.

FURANE RESIN SURFACE COATING.—Furane resin adhesives have distinguished themselves for high bonding strengths to plastics and rubber-like products, and unusually good gap-filling qualities. These characteristics are possible because of their high solids content. In response to many inquiries pertaining to the use of this material as a surfacing agent upon porous bodies such as concrete, wood, composition boards, plaster, etc., the Furane Plastics and Chemicals Company has developed a surface coating grade of Furane resin which has been widely approved.

This liquid resin is activated with a small amount of catalyst after which it may be spread upon various types of surfaces. Because of its high solids content, surface imperfections and defects in wood, concrete, etc., will be concealed. The coating will dry to the touch in approximately one half-hour after application and will set quite hard over night. The new Furane resin surface coating is characterized by the following outstanding features:—

1. Substantially complete resinous coating with negligible volatile material present.
2. Thermosetting plastic capable of drying in the air within a few hours.
3. Very heavy deposit may be laid in one brush coat, tending to hide surface defects, scars and scratches on relatively porous materials.
4. Complete chemical inertness to acids, alkalis, solvents and water.
5. Provides a black, high-gloss coating which will stand much weathering.

Typical applications suggested for Furane resin surface coating are: finishing and sealer coat for wood patterns; coating agent for laboratory table tops such as Masonite; impervious water-repellent coating for wood, ceramics and wallboards; excellent mould release agent when applied to dried plaster surfaces.

Unlike the low-viscosity impregnating resins developed by Furane Plastics and Chemicals Company, the Furane resin surface coating is designed to lay on the surface with a minimum amount of penetration.

MONSANTO CHEMICALS, LTD.—In his speech at the 12th Annual Meeting, the Chairman, Dr. L. F. Nickell, referred to improvements and extensions of processes that are now taking place in the company's works.

Respecting the company's further products, such as rubber chemicals, synthetic phenol, phthalic anhydride, salicylic acid and benzoic acid, similar improvements and marked increases of output are assured, and will be effected as soon as possible.

The accounts for the year ended December 31, 1945, show a profit after depreciation and provision for tax of £94,337, surplus and reserves of £1,046,034, current liabilities and provisions of £811,168, and current assets of £1,490,101. A tax-free dividend of £50,000 on the ordinary shares is recommended by the directors.

E. K. COLE, LTD.—Colonel D. Pritchard has been appointed to the Board of E. K. Cole, Ltd., as commercial director. As one of the youngest full Colonels in the British Army he was concerned in the early days with radar operation and later holding

important posts connected with supply administration. During the last year of the war in the capacity of Director of Radio Production for the British Air Commission, he was responsible for purchases totalling £100,000,000.

GEORGE COHEN, SONS AND CO., LTD., the well-known iron, metal and machinery merchants and engineers, announce that Mr. C. G. G. Boswood (hitherto Secretary and General Manager), Mr. A. S. Gill and Mr. C. E. G. Nye have been elected to the board as special directors. Mr. R. S. Ferry has been appointed secretary of the company.

GLASTICS, LTD., announce that the Ferndown (Dorset) offices have been transferred to Salisbury House, Finsbury Square, London, E.C.2. This office is in charge of two directors, J. A. Bennett and W. H. Bennett, who have just been released from H.M. Forces.

R. W. GREEFF AND CO.—The new offices are at 12, Finsbury Square, London, E.C.2.

MR. A. V. PERCIVAL has been appointed Managing Secretary to the Institute of the Plastics Industry; he has been Secretary, Joint Executive Committee of the Institute since 1944.

During the 1914-1918 war he was in the Machine Gun Corps and the R.F.C., obtaining his captaincy, and subsequently became engaged in the Drilling and Production Division, Shell Oil Co., in Canada, United States and Mexico. His more recent activities include that of London Manager of a member firm of the New York Stock Exchange, and Security Officer (Colonel) attached Northern Command, 1939-1941. He was seconded to the American Eagle Squadron, R.A.F., 1941-1943. He is a cricketer, having been captain of the Reading Cricket Club, 1938-1939.

STERNOL, LTD.—It is with deep regret that we announce the death of Mr. A. C. H. Bell Thompson on March 20. Mr. Thompson joined the predecessors of Sternol, Ltd., as far back as 1892 and gave his whole time and attention to the development of the oil trade in this country. He was the managing director of Sternol, Ltd., from its inception. By election of the oil trade he served many years on the Grand Council of the Federation of British Industries.

SOCIETY MEETINGS

Royal Institute of Chemistry and Institute of Physics—Joint Meeting

At a joint meeting arranged annually by the London and Home Counties Section of the Institute of Physics and the London and South-Eastern Counties of the Royal Institute of Chemistry at the Royal Institution on March 20, a symposium and discussion on "Polar Molecules and Dielectric Problems" was held, and Dr. G. L. Riddell, F.R.I.C., was chairman.

Dr. S. Whitehead introduced the theoretical ideas associated with the behaviour of dipoles under electrical stress and showed how the original ideas of Lorentz had been modified by later workers on the subject. Mr. A. J. Maddock, M.Sc., F.Inst.P., gave a historical résumé of the practical aspects, commencing with Siemens, 1864, who first observed the heating effects of H.F. energy, followed in 1891 by Tesla, who applied the phenomenon to Diathermy. Practical advances, many the subject of patents, were made in U.S.A., France and Germany, but it was not until 1942-3 that the commercial use of dielectric heating became available for the thermosetting of plastic resins. Because the dielectric material is heated uniformly throughout the mass and only thermal loss is suffered at the surface by air cooling, the application of high frequency heating is now largely employed for the manufacture of laminated boards and shaped laminated pressings. It has possible fields in processes of drying, dehydration and cooking.

Mr. N. J. L. Megson, M.Sc., F.R.I.C., gave an account of the constitution of plastics and the effect of polar molecules on their constituents and explained the changes which thermosetting and thermoplastic materials undergo when they are heated.

PATENT REVIEW

The following abstracts have been made from specifications at the Patent Office, with the permission of the Controller of H.M. Stationery Office. Complete specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

B.P. 573,809. Application date: 28.7.42. Accepted: 7.12.45.

Improvements in or relating to the Manufacture of Interpolymers or aromatic Vinyl Hydrocarbons with other polymerizable organic compounds and of coating compositions obtained therefrom. L. E. Wakeford, D. H. Hewitt. To: Lewis Berger and Sons, Ltd.

B.P. 573,811. Application date: 7.12.42. Accepted: 7.12.45.

Manufacture of Vulcanized Materials. J. G. Cook, D. A. Harper, R. J. W. Reynolds, W. F. Smith. To: I.C.I., Ltd.

Process for the manufacture of vulcanized materials by heating mixtures of an organic diisocyanate modified unsaturated polyester or polyester-amide, sulphur and a vulcanization accelerator. The mixture may further contain fillers, plasticizers, stabilizers and detackifying agents.

B.P. 573,826. Application date: 28.9.43. Accepted: 7.12.45.

Manufacture of Condensation Products of Lac and Compositions made therewith. B. S. Gidvani. To: Indian Lac Cen. Cttee.

B.P. 573,835. Application date: 14.12.43. Accepted: 7.2.45.

Improvements in or relating to the manufacture of Interpolymers of Styrene with Polyhydric Alcoholic mixed Esters and of Coating Compositions therefrom. L. E. Wakeford, D. H. Hewitt and F. Armitage. To: Lewis Berger and Sons, Ltd.

B.P. 573,839. Application date: 3.4.42. Accepted 10.12.45.

Improvements in and relating to Thermoplastic Compositions. E. F. Brookman and L. M. Smith. To: I.C.I., Ltd.

Refers to a thermoplastic composition based on polyvinyl halides, being plasticized and capable to be gelatinized to a solid article.

B.P. 573,840. Application date: 7.5.42. Accepted: 10.12.45.

Improvements in and relating to Thermoplastic Compositions. E. F. Brookman and S. F. Pearce. To: I.C.I., Ltd.

Improved composition comprising one or more vinyl halide polymers in homogeneous admixture with one or more plasticizers and chlorinated paraffin wax (having a chlorine content of 10-55 per cent.).

B.P. 573,841. Application date: 3.4.42. Accepted: 10.12.45.

Improvements in and relating to Thermoplastic Compositions. E. F. Brookman and S. F. Pearce. To: I.C.I., Ltd.

B.P. 573,842. Application date: 10.4.42. Accepted: 10.12.45.

Improvements in or relating to Sheet Materials comprising Polyvinylchloride. J. H. McGill. To: I.C.I., Ltd.

Method of improving the calendering of PVC sheets and at the same time to improve the surface of the sheets, consists of adding 2.5-25 per cent. methyl methacrylate to the PVC, gelatinized by means of a liquid which is an active plasticizer for both polymers.

B.P. 573,844. Application date: 18.5.42. Accepted: 10.12.45.

Interpolymers of Iso-olefines. D. W. Huebner and J. E. Fearey. To: I.C.I., Ltd.

Process for making interpolymers of an iso-olefine (iso-butylene) and vinyl methacrylate by subjecting their mixture to the action of a Friedel-Craft catalyst at a temperature below −10 degrees C.

B.P. 573,845. Application date: 18.5.42. Accepted: 10.12.45.

Interpolymers of Iso-olefines. D. W. Huebner and J. E. Fearey. To: I.C.I., Ltd.

Process for making an interpolymer of an iso-olefine (iso-butylene) and vinyl methacrylate by subjecting their mixture to the action of a Friedel-Craft catalyst at temperatures below −10 degrees C.

B.P. 573,865. Application date: 21.12.43. Convention date (Germany): 10.4.43. Accepted 10.12.45.

Improvements in or relating to a process for removing the air contained in Casein Solutions of High Viscosity. R. Signer.

Process of preparing casein spinning solutions by raising the temperature of a sodium caseinate solution to 50 degrees C. in a closed vessel and subsequently evacuating

I.C.I. Service in PLASTICS

I.C.I. manufacture the following plastics:

Polythene

Methyl Methacrylate

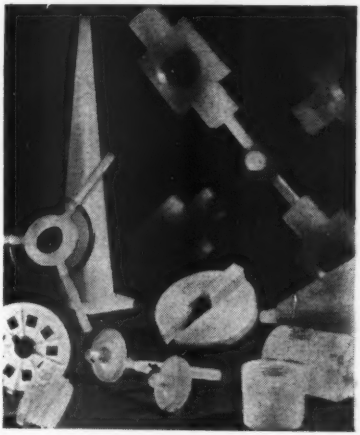
Nylon

Polyvinyl Chloride

Urea Formaldehyde

Phenol Formaldehyde

Moulders and manufacturers are invited to discuss their plastics problems with I.C.I. Technical and Research staff whose services are freely available.



ONE OF THE OUTSTANDING I.C.I. PLASTICS

Polythene, on account of its excellent dielectric properties at ultra high frequencies, was used with outstanding success in Radar components throughout the war. Polythene is light, tough and flexible. It is water-resistant and will withstand immersion in boiling water. All these properties combine to render it an excellent material for injection moulding. "Alkathene" is the trade name for the I.C.I. brand of polythene which is produced in natural or coloured granules.

ICI

IMPERIAL CHEMICAL INDUSTRIES LTD.
LONDON, S.W.1

P.182

time marches on

—and new methods and materials make their mark. This clock dial, for example, is injection-moulded from BEXOID (Cellulose Acetate) POWDER. It shows the accurate and clean finish of injection-moulding, an ideal process for the quick and economical manufacture of many diverse articles, from combs and fancy goods to electrical parts. For information on the latest developments in the application of plastic materials to modern methods of manufacture, consult:

BX Plastics Ltd. LARKSWOOD WORKS, LONDON, E.4
LARKSWOOD 4491

BX273

the vessel to a pressure at which the solution boils and foams. Reduction of pressure is continued to break down the foam.

B.P. 573,866. Application date: 14.12.42. Accepted: 11.12.45.

Improvements in or relating to Amino-Formaldehyde Resins. J. R. Alexander, D. Burton, F. Hausmann. To: W. Walker and Sons, Ltd.

Amino-formaldehyde resin plasticized by an inorganic lactate.

B.P. 573,878. Application date: 22.12.43. Accepted: 11.12.45.

Improvements relating to the Production of Plastic Compositions. E. W. M. Fawcett, E. S. Narracott, K. I. Rowland. To: Anglo-Iranian Oil Co.

Plasticized polyvinyl chloride or polyvinyl chloride copolymers for use as coating compositions, cable compounds and moulding compositions.

B.P. 573,887. Application date: 24.12.43. Accepted: 11.12.45.

Adhesive Compositions. B. J. Balfe. To: I.C.I., Ltd.

Adhesive composition containing a water soluble urea-formaldehyde condensation product and 10-25 per cent. of fish glue.

B.P. 573,906. Application date: 22.4.43. Accepted: 12.12.45.

Process for the production of Organo Substituted Silicon Compounds. C. Bondy and K. Reiser. To: Revertex, Ltd.

Process for producing organo substituted silicon compounds by reacting an alkyl orthosilicate (methyl orthosilicate) with an alkyl, cyclo alkyl, aryl or aralkyl halogenide and an alkali metal (sodium).

B.P. 573,932. Application date: 7.8.42. Convention date (U.S.A.): 23.7.41. Accepted: 13.12.45.

Bonding of Polymeric Materials to the Surface of Articles. To: Imperial Chemical Industries, Ltd.

Process of uniting an active hydrogen containing polymeric material to the surface of an article composed of a different active hydrogen containing polymer by bringing the two together in the presence of an organic polyisocyanate.

B.P. 573,960. Application date: 22.4.43. Accepted: 14.12.45.

Process for the Production of Organo Silicon Polymers. C. Bondy and K. Reiser. To: Revertex, Ltd.

Process for the production of organo silicon polymers by hydrolysis with water or aqueous solutions followed by a heat treatment of the products so obtained.

B.P. 573,963. Application date: 12.5.43. Accepted: 14.12.45.

Improvements in or relating to the provision of Plastic Compositions of a Putty-like nature in forms suitable for ready use. L. E. Puddefoot, S. Reckless and L. E. Wilson. To: B.B. Chemical Co., Ltd.

Plastic composition of a putty-like nature to be used for glazing or sealing. This putty is supplied in a string-like form, wound into a coil with a separating string between the individual layers.

B.P. 573,965. Application date: 26.7.43. Accepted: 14.12.45.

Manufacture of New Rubber-like Polymeric materials. C. J. Mighton. To: E. I. Du Pont de Nemours.

Process for producing a polymeric material by interpolymerization of a halogen-substituted 1:3 butadiene with an ester of an alpha-unsaturated alpha, beta-dicarboxylic acid and a monohydric unsaturated alcohol.

B.P. 573,966. Application date: 27.7.43. Accepted: 14.12.45.

Cellular structures and methods of producing same. D. Parsons. To: Revertex, Ltd.

Relates to the production of cellular structures comprising one or more polyvinyl acetals. Partially esterified polyvinyl alcohols are reacted with an aldehyde or substances yielding aldehydes whilst the starting material is in a foamed condition. Final setting by heat.

B.P. 573,988. Application date: 7.4.43. Convention date (U.S.A.): 25.8.42. Accepted: 17.12.45.

Process for the Preparation of Halogen Derivatives of Rubber and Rubber-like Materials. F. J. Bouchard. To: Hercules Powder Co.

B.P. 574,003. Application date: 2.11.43. Accepted: 17.12.45.

Improvements in and relating to methods of preparing liquid Silicones. R. Snadow. To: The British Thomson-Houston Co., Ltd.

Method for making mixtures of alkyl and/or aryl liquid silicones which can be polymerised to a resinous material from a mixture of alkyl or aryl silicon halides by first reacting the halides with a monohydric alcohol and subsequently hydrolising the compounds so formed to liquid silicones.

B.P. 574,012. Application date: 1.10.41. Accepted: 18.12.45.

A new or improved Moulding Powder. H. Kremer.

See also B.P. 541,944. Concerns a moulding powder containing a filler, and a mixture of natural or synthetic rubber and liquid blood.

B.P. 574,014. Application date: 24.10.41. Accepted: 18.12.45.

Improvements in or relating to the production of textiles and other articles having a basis of a Polyvinyl compound. H. Dreyfus.

B.P. 574,016. Application date: 20.11.41. Accepted: 18.12.45.

Melamine Formaldehyde Resins. W. W. Triggs. Communicated by: American Cyanamide Corp.

Process for making melamine-formaldehyde resins by reacting formaldehyde with melamine (in proportions 3 to 1) at controlled pH at temperatures between 50-90 degrees C., adjusting the pH, dehydrating in vacuo and cooling.

B.P. 574,020. Application date: 4.11.43. Accepted: 18.12.45.

Improvements relating to the manufacture of Resins from crude Benzole and like Hydrocarbons. L. Shuttleworth and R. A. Randall. To: Dorman, Long and Co., Ltd.

B.P. 574,031. Application date: 29.11.43. Accepted: 18.12.45.

Improvements in or relating to Solid Polymers. E. Hunter and R. B. Richards. To: Imperial Chemical Industries, Ltd.

Process for fractionating mixtures of solid polymers and also for comminuting these polymers by dissolving the solid polymers in gas at high temperatures and high pressures, afterwards partially reducing pressure and temperature and separating the powder. Applicable to polythene, polyisobutylene, polyvinyl-chloride, polystyrene and polymethyl methacrylate.

B.P. 574,034. Application date: 10.12.43. Convention date (U.S.A.): 10.12.43. Accepted: 18.12.45.

Polymers and Copolymers of Esters of Vinyl Oxyacetic Acid. To: E. I. Du Pont de Nemours.

B.P. 574,054. Application date: 3.4.42. Accepted: 19.12.45.

Improvements in and relating to Condensation products containing Rubber. I. Marshall. To: Imperial Chemical Industries, Ltd.

Refers to the production of a thermosetting resin by reacting a mixture of phenol, oxidized rubber and an aldehyde and condensing it with an aliphate diamine (ethylene diamine). The resins so obtained may be used for making laminated articles, moulded compositions, adhesives and impregnating agents.

B.P. 574,095. Application date: 28.6.43. Accepted: 20.12.45.

Improvements in or relating to Synthetic Resin Adhesives. E. L. R. Mowat. To: Aero Research, Ltd.

Synthetic resin adhesive particularly for making gap joints, comprising a cold-setting urea formaldehyde resin, cellulose filler and an aliphatic or alicyclic alcohol, aldehyde or Resone.

B.P. 574,126. Application date: 1.1.42. Accepted: 21.12.45.

Improvements in or relating to the sealing of joints or the like, or in or relating to compositions suitable for use in connection with such sealing. R. E. Puddefoot, W. H. Swire and A. D. Woods. To: B.B. Chemicals Co., Ltd.

Compositions for sealing aircraft cabins for use at abnormally low temperatures.

B.P. 574,134. Application date: 26.10.42. Accepted: 21.12.45.

Improvements in the manufacture of synthetic polymeric materials. D. H. Coffey, J. G. Cook and W. H. G. Lake. To: Imperial Chemical Industries, Ltd.

Relates to the manufacture of organic diisocyanate modified polyesters or polyester-amides.

B.P. 574,139. Application date: 20.10.43. Accepted: 21.12.45.

An improved method of jointing, terminating or repairing the covering of an electric wire or cable. P. Jones and E. W. Mills. To: British Insulated Cables, Ltd.

B.P. 574,157. Application date: 13.3.44. Accepted: 21.12.45.

Improvements in or relating to the manufacture of embossed sheet material comprising a Polyvinyl Chloride Plastic Composition attached to a substrate. J. H. McGill. To: Imperial Chemical Industries, Ltd.

B.P. 574,168. Application date: 22.1.44 and 10.1.45. Accepted: 27.12.45.

Improvements in or relating to the Coating

of Metal and like Surfaces with Resinous Coating Materials. A. Hershberger. To: E. I. Du Pont de Nemours and Co.

Coating for light metals consisting of polyvinyl acetals, polyvinyl acetate and polyvinyl chloride.

B.P. 574,173. Application date: 7.1.44. Convention date (U.S.A.): 9.1.43. Accepted: 27.12.45.

New and improved plasticized Vinyl Resin Composition. To: Imperial Chemical Industries, Ltd.

Refers to a coating composition for outdoor use, prepared from a vinyl-chloride-vinyl-acetate copolymer (90 : 10) with an alkyl ether alcohol ester of an aliphatic dicarboxylic acid and plasticizer.

B.P. 574,220. Application date: 27.7.42. Accepted: 28.12.45.

Improvements in or relating to Rubber Substitutes and Process for the Manufacture thereof. V. Haas.

Relates to the production of factice by treating linseed oil, rape oil, castor oil and the like with a vulcanizing agent (sulphur).

B.P. 574,247. Application date: 21.1.44. Convention date (U.S.A.): 21.1.43. Accepted: 28.12.45.

Improved plasticized Polyvinyl alcohol composition. To: Imperial Chemical Industries, Ltd.

Polyvinyl alcohol composition suitable for moulding and extrusion containing a solid polymer of formaldehyde as plasticizer; glycerol and glycerol esters may also be added for plasticizing.

B.P. 574,270. Application date: 4.9.42. Accepted: 31.12.45.

Manufacture of Rubber-like Materials. C. A. Curtis and D. S. Stephens. To: Clayton Aniline Co., Ltd.

Rubber-like materials obtained by reacting a thioaldehyde or a mixture of a thioaldehyde and an aldehyde with sulphur at a temperature between 50-200 degrees C., and adjusting the pH.

B.P. 574,272. Application date: 15.9.42. Accepted: 31.12.45.

Improvements in or relating to the manufacture of Rubber-like Plastics. K. Wallersteiner.

Plastics obtained from castor oil by decomposition (under heat) under reduced pressure in the presence of magnesium or sodium or an organic peroxide as accelerating catalyst. Acrolein, heptaldehyde, etc., are removed by distillation before polymerization takes place.

B.P. 574,309. Application date: 31.1.44. Accepted: 31.12.45.

Coating of Metal Surfaces with Polythene or Polythene compositions. G. W. Worrall. To: Imperial Chemical Industries, Ltd.

B.P. 574,320. Application date: 16.5.40. Accepted: 1.1.46.

An improved manufacture of Rubber or other thermosetting material in cellular form. G. M. Hamilton. To: Callender's Cable and Construction Co., Ltd.

Method of producing cellular hard rubber (ebonite) by vulcanization in steps, i.e., the rubber is partially vulcanized by heating to a temperature below 150 degrees C., the temperature is then raised so that a gas-producing substance (ferrous oxalate) incorporated in the mix can decompose and expand. This is followed by complete vulcanization.

B.P. 574,382. Application date: 16.3.43. Accepted: 3.1.46.

Improvements in or relating to the manufacture of cellular material of low density. E. V. Appleton, R. C. Rose and P. H. Plesch. To: Cefoil, Ltd.

Cellular material produced from a foamed alginate solution, using chromium, calcium and zinc salts as setting agents. Fillers may be added as well as casein solutions and formaldehyde.

B.P. 574,448. Application date: 8.9.41. Accepted: 7.1.46.

Improvements in or relating to laminated materials. H. N. Shelmerdine. To: Expanded Rubber Co., Ltd.

Laminated material consisting of an expanded rubber sheet faced on both sides by a veneer. Between the rubber and the veneer balsawood is inserted.

B.P. 574,449. Application date: 8.10.41. Accepted: 7.1.46.

Polymerization of Vinyl Organic Esters. R. G. R. Bacon and J. R. Lewis. To: Imperial Chemical Industries, Ltd.

Refers to polymerization in aqueous media with a water-soluble persulphate catalyst.

B.P. 574,454. Application date: 22.5.42. Accepted: 7.1.46.

Copolymers of Trichloroethylene. To: E. I. Du Pont de Nemours and Co. (Communicated to Imperial Chemical Industries, Ltd.).

Planned Mould Maintenance Service Aids Economical Production

Section XVIII (contd.)

By W. M. HALLIDAY

Describing and illustrating an extremely efficient yet simple automatic feed of the gravity type, representative of a widely used kind, for obtaining rapid delivery of a cylindrical insert component to a multi-impression injection mould.

Incorporated with this feed mechanism is an essential simple self-acting sorting device, again typical of a useful class of device, which ensures unfailing delivery of each insert with its reduced squared end foremost. This mechanism is also illustrated and its application explained.

In the preceding portion of this section of the series, published in the February issue of " Plastics," it will be recalled that the author there dealt at considerable length with a number of vitally important general considerations to be borne in mind when applying fully automatic feeding mechanisms for insert delivery to injection moulds.

Such points then discussed apply with interest to practically every type of automatic insert feeding, and having cleared away such general factors and their effects, it is now clear to proceed with a rather more detailed study of a number of particularly representative examples selected by the author as being typical of either a generally used or interesting type of design, or construction, or both.

Method of Presentation

A preliminary note about the method of presentation of these illustrated examples of mould designs will perhaps be desirable. Unfortunately, space forbids the giving of more than one example of each type, but readers will appreciate that numerous well-defined design forms are in use, and in addition each type is capable of manifold adaptations and modifications.

It is not practicable to give attention to each of those applications. Instead, one fairly general type of insert is selected and a typical feeding mechanism shown for dealing with that insert. This design will be examined in close detail as in previous sections of the series, and again concentration will be devoted to those preferable and undesirable designs, to mechanical, and constructional features which will be conducive or harmful, as the case may be, to smooth and efficient mould operation, absence of serious working faults, and the minimum of skilled maintenance upkeep.

The preferred design forms, etc., in every case suggested will be those which it has been found from actual working practice give the best results, especially when viewed from the angle of mould maintenance and smooth operation.

The present writer would strongly urge upon mould designers the essential need to bear in mind when evolving new mould designs for automatic feeds, the prime requisites for trouble-free running mentioned at some length and exhibited clearly in the following illustrations. To assist such designing activities the author will endeavour to emphasize sharply the fundamental mechanical features conducive to economical production and mould operation, as a clearer understanding of these will more readily enable their embodiment in other applications of a similar type which may occur from time to time.

Automatic Gravity Operated Insert Feed Actuated by Block Movements

The first example chosen for careful consideration is perhaps one of the most commonly employed on account of its many practical advantages. It is chiefly used in the feeding of cylindrical insert

components either in single or multi-impression tools. This method makes use of the gravitational force of the insert components themselves for carrying them from the container remote from the mould block, to the cavity area within the mould, and to their correct location in readiness for moulding with every cycle of movement of the blocks.

Referring to the illustration shown in Fig. 1, giving a sectioned view of the automatic feeding mechanism contained in a portion of the movable block, it will be observed that the mould is of the multi-impression type, having 12 cavities, six of which only are shown. These six impressions are located one side of the centre sprue orifice, the opposite side also having six impressions, and identical feeding arrangements for the inserts.

The view is of the parting line surface of the movable mould block A, containing half portions of the cavities. The moulded component has a cylindrical shank of several different diameters, and a ring-like end portion as shown. Into the right-hand end of the cylindrical part is moulded a cylindrical insert pin, one end of which is squared in order to secure additional retention against rotation when moulded in place.

Because of the necessity to part the moulds along the centre line of the length of the components, the means adopted for holding the insert pieces in proper place during actual moulding must be of such a character as to permit adequate withdrawal of same to afford clearance to the finished moulding and its insert in each case when the ejection stage of the cycle is reached. How this is simply accomplished will be explained later.

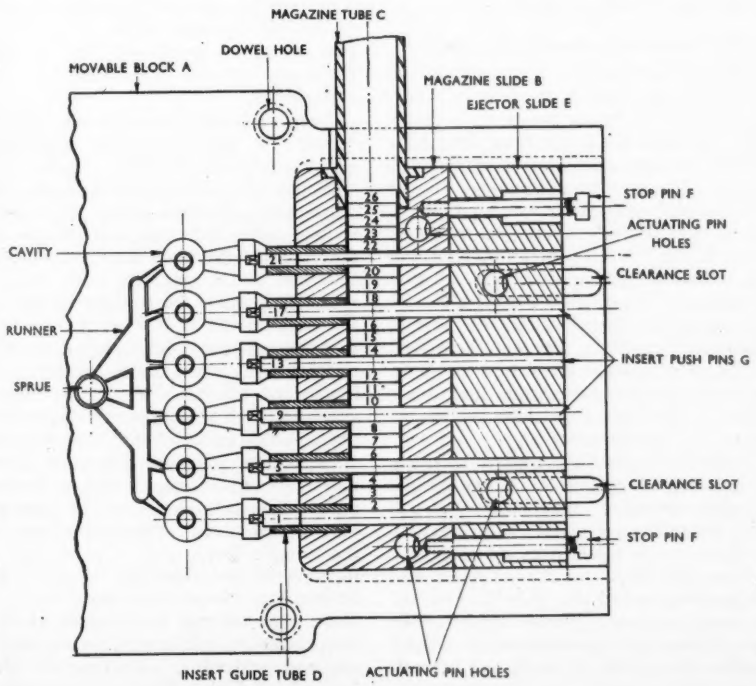


Fig. 1.

The housing for the automatic feeding mechanism is contained within the movable mould block A, this member having an extended portion at one side as shown. It is machined out in a suitable manner so as to form a horizontal channel with inclined side faces set exactly parallel to each other and perfectly parallel with the centre line of the mould block itself. Fitted very carefully into this guideway are the two dovetail slides, viz., magazine slide B and ejector slide E. These two members are fitted so as to have free independent movement along the guideways and are actuated by means of pairs of angularly disposed operating pins anchored to the stationary mould block, and so arranged as to project a sufficient distance beyond the parting line face of that member to ensure the requisite amount of engagement with the two slides for producing a predetermined length of stroke.

The Insert Magazine Holding Device

Fitted to the top of magazine slide B is a mild steel tube C, the bore of which is rectangular in cross-sectional shape. The dimensions of this bore should be slightly larger than the diameter and length of the insert component to be handled so as to allow these members to move unrestrictedly along the magazine tube during feeding operations. It will be noted that this magazine tube is attached to the top of the slide B by means of a threaded shank and a shouldered portion. This enables a tube to be very quickly fixed to slide B or equally rapidly removed, and the advantages of this non-permanent method of fixture will be apparent later.

To hold the insert components correctly in position during feeding and actual injection moulding slide B is equipped with six mild steel guide tubes as at D.

These guide tubes are made a very tight press fit at their right-hand end within holes bored into slide B. As will be seen, the mould cavities are extended towards the right to provide short parallel recesses into which the front end of each guide tube is made a close sliding fit.

The tubes are made long enough to pass through the connecting wall in mould block and into the mould cavity area a sufficient distance so as to effect sealing off of the cavity when slide B is in its completely closed position as shown in Fig. 1.

In order to obtain proper retention of the insert pins the bore diameter of each insert tube D is made just large enough to permit the insert being a snug press fit within yet free enough to move along the bore under moderately light pressure. Undue slackness, or extreme tightness of fit must be avoided, as such features would lead to numerous operating troubles, and perhaps faulty functioning of the feeding device.

For the same reason, it will readily be appreciated, the outside diameter and overall length of each component insert should be held within close limits, otherwise troubles such as jamming of inserts within the feeding tubes; or displaced positioning of inserts due to vibration from other mould movements, etc., can easily occur.

The insert guide tubes D are so situated within the slide B as to bring their extreme right-hand ends exactly flush with the left-hand vertical wall of a slot machined or formed within the slide as shown. This slot extends practically the full length of the slide in a perfectly vertical line, and is made the exact identical shape and size as the rectangular bore of the magazine tube C. The latter member is so arranged that its bore and the slide slot form an uninterrupted channel. The lower end of this slot in slide exactly coincides with the bottom of the hole in the first insert guide tube D as indicated.

It may be wondered how such a very deep rectangular-shaped slot is formed within the slide since only a sectional view is here given. The method used by the writer is first to endmill a slot into the top face of the slide, making this about 50 per cent. deeper than the actual slot width required. A blanking-off plate is then carefully fitted into the mouth of the slot and held either by screws or rivets finished off flush. This is a very simple

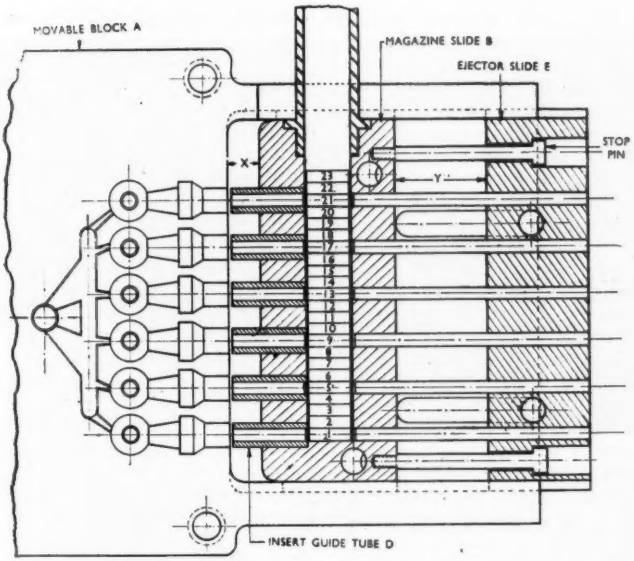


Fig. 2.

and inexpensive way in which such a slot may be obtained.

The depth of this slot in relation to the first guide tube especially is extremely important, as will be discerned later when we reach the point of explaining the method of operating this feeding device.

Mechanism for Ejecting Inserts from Magazine

The ejector slide E carries six push pins G which are located very tightly within the slide and undergo all movements with the slide. The remaining projecting portion of each pin is made a sliding fit within matching holes drilled through the magazine slide B in its wall portion to the right of the magazine slot. In length of projection these push pins are long enough to pass through slide B and into the bores of insert tubes D sufficient to bring each insert into its correct endwise location within the tube when slides B and E are brought to the closed position.

In the interests of free and smooth operation, it will be essential for the push pins to be located in slide E accurately so as to be capable of moving easily through slide B and its guide bushes D. Any binding action at these points will tend to slow down production and even result in serious seizure of the pins at some point.

Magazine slide B has a very short length of travel along the dovetail guides in block A, this distance, in fact, being only sufficient to withdraw the insert tubes D clear of the moulded-in insert pin after each injection shot has been made. As slide B is moved outwards the tube D slides over the now secured pin leaving it undisturbed until the entire moulding is ejected in normal manner by pins operating at right angles to the parting-line surface.

Ejector slide E, however, must have a much longer stroke since the push pins G fitted to it must be retracted until the front ends of the pins are brought back slightly beyond the right-hand wall of the vertical magazine slot in slide B in which the stock of inserts is housed.

These points will be more explicitly understood by referring to drawing, Fig. 2, which shows the various mould parts in their open or loading positions.

Whilst it is essential that the two slides be entirely independent in their respective motions and of different lengths of stroke, slide E is restrained from coming completely adrift from slide B by reason of two headed stop pins F which are fitted. These pins are screwed down into tapped holes in the right-hand side of slide B, passing through clearance holes in slide E. This latter member is deeply counterbored around each hole as shown to allow the head portion of pin to lie well below right-hand end face of slide.

The reason for this method of fixing the pins is that it allows a considerably shorter stop to be employed and so ensures greater clearance with machine platen guides or other adjacent members.

The stop pins should be made sufficiently long to allow slide E to move towards the right during opening movements until push pins G reach the correct endwise position to clear insert magazine slot as previously explained.

By means of this independent operation of the two important feeding slides B and E, it is easily possible to impart different rates of travel and speeds, or to allow one slide to dwell for a portion of the cycle as may be necessary when dealing with certain types of insert, or by exigencies of mould construction.

Sequence of Operations

The method of operating this automatic feeding mechanism will now be simply explained, but readers will doubtless have gathered the essential features of same from the foregoing constructional details.

A quantity of insert components, several times greater than the number of mould cavities to be fed at each shot, is stacked up in the magazine slot in slide B and its detachable extension tube C, as is indicated in the drawings Figs. 1 and 2, each insert piece being numbered from one upwards.

As both slides have been moved to the closed position when mould blocks are brought together, shown in Fig. 1, push pins G have passed clean through the slot in slide B, carrying before them inserts marked 1, 5, 9, 13, 17 and 21 respectively. These members have been carried forward until their squared ends project into the cavity area a sufficient amount. The push pins when making this movement also automatically cut off the supply of further inserts in the slot in slide B. When the mould is completely closed slide B will be bearing down tightly against the vertical wide wall of the guideway recess in block A, whilst slide E will similarly be contacting closely with right-hand side of slide B.

When the injection shot has been made the mould is opened in normal manner, this action causing both slides B and E to be moved backwards along the guideway. Magazine tube extension C will also travel with slide B, a clearance step being machined along the rest of face of movable block for this purpose.

Continued opening movement of the slides serves to withdraw slide E sufficient to bring the ends of push pins G clear of the magazine slot, whereupon the column of insert components will fall down until arrested by the bottom of slot. In this position each fourth insert from No. 1 is again brought into exact horizontal alignment with the bores of sleeves D in readiness for the next closing movement of the slides.

This will be perfectly clear by referring to the sectioned drawing, Fig. 2, which shows the respective positions of the mould members when in the open stage and immediately prior to the placing of another complement of insert pieces into position within the cavities.

For clearness the comparative lengths of slide movements is indicated by the symbols X and Y.

One very important factor must be pointed out in connection with the use of an insert feed mechanism of this type. It is as follows: The distance apart of the cavity centres and hence the insert guide tubes and their connected push pins, etc., must be made an exact multiple of the largest diameter portion of the insert to

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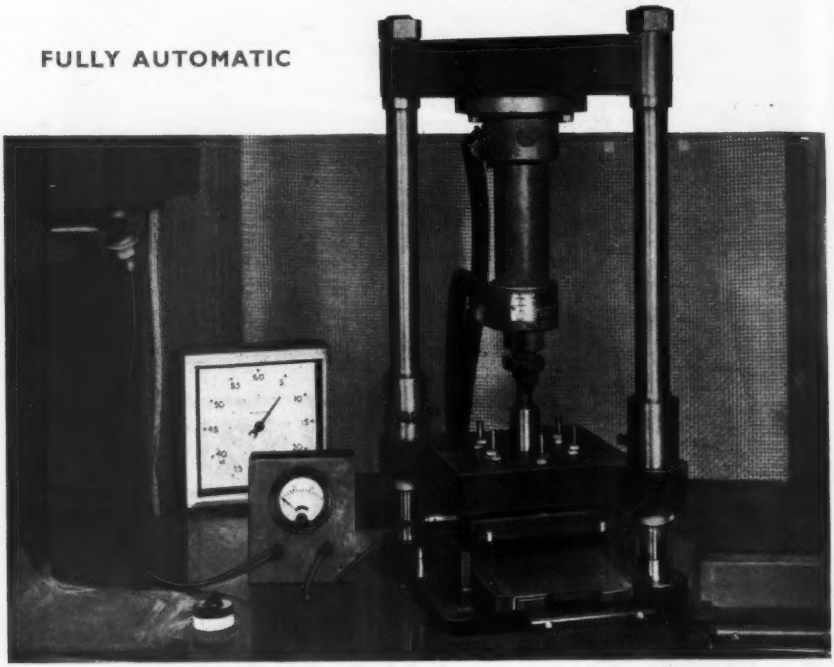

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be dealt with. In the case of square or hexagonal shaped insert components the distance across flats will have to be taken and cavity centres made precise multiples thereof. Even slight deviations will give rise to operating snags and troubles, and perhaps undue wear upon some vital member of the construction.

The right-hand end of sleeves D should be well chamfered on their bores so as to afford a good smooth lead in for push pins G as well as the insert component ahead of pin.

Advantages of the Design

From a design, construction and cost viewpoint, this type of automatic insert feed has many things to commend it, and because of these the type enjoys very widespread usage in either original or slightly adapted form.

Briefly enumerating these advantages, it should be specially noticed that the design in its illustrated form is best suited to short or medium-sized production runs.

(1) **Extreme Simplicity**

As will be appreciated, this design involves the use of a minimum number of moving parts, and the shape and motion of these parts is of the simplest nature, i.e., straight-line reciprocation. The mechanism is of such a simple character mechanically as will permit ready incorporation with many existing mould designs not specifically planned for automatic gravity feed. Indeed, the author has incorporated such a type of feeding mechanism quite easily and inexpensively to a mould not initially intended for operation of this kind.

(2) **Rapid and Smooth Operation**

Partly because of the simple nature of the mechanical movements involved, but also to some extent because of the sound underlying design principles, extremely high-speed operation can be secured, coupled with very smooth reliable action.

Access to the moving parts of the feeding mechanism is easily obtained, thereby greatly facilitating cleaning and lubrication operations, which again assist materially towards smooth running and prolonged working life.

By reason of the sliding motion obtained from inclined pins, very quiet and efficient operation results, this helping to maintain the additional load on the mould exceedingly light.

This is an important point worthy of the attention of the mould designer, who very often is reluctantly compelled to discard all thoughts of employing fully automatic insert feeds on a particular mould lay-out by reason of the great additional load it would impose on the moulds, or the drastic slowing up of production its use would entail. Or, on the other hand, use of some kinds of feeding devices would prove so costly, or produce such an unbalancing effect upon other vital mould members or movements.

(3) **Positive Delivery**

Here, again, one great advantage possessed by this design relates to the extreme surety with which the insert components are delivered and positioned within the mould area. Very accurate delivery is assured. This is a very weighty advantage which will commend itself to most designers who will always be well advised to select and install the most positive and fool-proof kinds of apparatus possible.

(4) **Capacity of Automatic Feeder**

This form of automatic feeding device is capable of dealing with quite a wide range of insert component shapes and sizes, but, of course, in every instance the exterior dimensions must comprise substantial parallel portions in order that the parts may roll or slide, or stack-up readily and uniformly with the magazine tube incorporated in the device.

It is also readily possible by extending the detachable magazine tube C to hold a sufficiently large number of inserts so as to cover many injection "shots," even when used in conjunction with a multi-impression mould.

By making the extension magazine tube C detachable from slide B, it is possible still further to increase the loading capacity of the feeder. This is secured

by the simple provision of a number of identically shaped extension tubes, as at C. Thus whilst one tube is affixed to the mould and being emptied, others are being filled in appropriate manner, and it is the work of only a few moments to effect exchange of a full magazine for an empty one. In this manner almost continuous production can be maintained at extremely low extra cost.

(5) **Safe Operation**

One of its main advantages lies in the high degree of safety in operation afforded by this construction. For example, one of the chief bugbears of the mould engineer is that of providing effectively against the inadvertent omission of an insert and the resultant damage caused by this. No serious troubles can arise should an insert be omitted, because the plastic material cannot pass into the guideways or amongst other parts of the mechanism, due to the stopping-off action of the push pins within the insert guide tubes D.

After such a faulty shot, when the slides are moved back to their open position the portion of plastic stem formed within the vacant bore of tube D will be stripped from the insert tube quite easily and can then be ejected as usual.

(6) **Adaptability**

In the present case, as illustrated in Figs. 1 and 2, the feeding mechanism is shown arranged for horizontal operation, this being the most suitable location and method for this particular mould layout and application to cavities.

It will be appreciated, however, that with only very slight modifications the two essential slides B and E can be so arranged to function within vertical guideways, or along inclined ones at any convenient angle to suit feeding cavities disposed other than in the manner here depicted.

When slides are arranged for vertical or steep inclined operations it will entail employing some means whereby they are retained in their outward position after the inclined actuating pins in the stationary mould block have been disengaged from the slides. If some such provision as this is not made there will be a risk of the slides falling down after being cleared of the actuating pins and so resulting in a serious jam of working members if not noticed by the operator. The mould blocks may thus become inadvertently closed.

A further illustration of the adaptability of this construction is to be noted in regard to the wide variation in length of slide travel permissible. By altering the amount of projection or angle of inclination of the actuating pins situated in the stationary block it is easily possible to obtain very lengthy or very short strokes for each slide.

In cases where a moulded-in insert has to project an exceptionally large amount from the plastic moulding, or where it has to be of extremely long overall distance in comparison to its width of diameter, so requiring increased travel of the ejector or magazine slides, actuation of the latter may be secured from fixed cam plates instead of inclined pins.

This method of slide operation is one well understood and known to mould designers and usually embraces a cam-shaped plate fastened to the machine frame or fixed platen. Its use enables varying speeds to be secured to a slide throughout different portions of its stroke, a feature very often of the greatest practical use in reducing or balancing out the load upon a mould construction.

Yet another very simple method of operating the two slides B and E will offer itself to the mould engineer. This will comprise a joining together of the two slides by means of a steel link or links one end of which is drilled to receive a shackle pin in turn anchored to one slide, whilst the other end of the link will be machined with an elongated slot through which is a shackle pin fastened to the second slide. This will enable one slide to be moved a certain specified distance before the other slide, again a very useful and sometimes necessary feature in order to reduce the load

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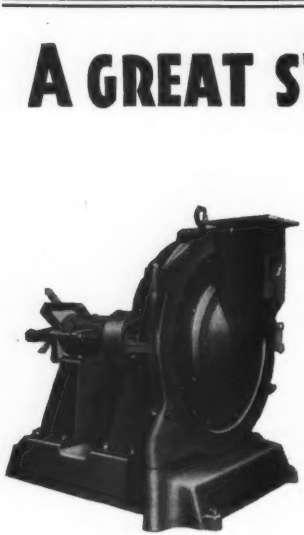

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upon a mould, as when, say, a core slide has to be withdrawn simultaneously with the operation of the feeding slides.

In addition, only one slide needs operating by angular pins or cams, this making for further economy of mould components.

(7) **Compactness**

Yet another very valuable advantage lies in the compactness of this design. It will be seen that practically the entire feeding mechanism is contained within the movable block alone, or, rather, in an extension at the side of this block. Incidentally, such an extension need not be an integral part of block, but could very easily be a built-in structure.

In the case of multi-impression moulds very often space is severely restricted on the mould itself, making it somewhat difficult to extend the main blocks substantially for housing the automatic feeder.

Another useful point associated with its compactness is in respect of storing the mould when not in production use. Since all the mechanism is contained in the movable block little difficulty will be experienced in storage of the mould, and there will be reduced risk of parts becoming damaged or lost, as is the case when a number of loose components are to be handled and stored.

Disadvantages of the Design

Notwithstanding the numerous advantages, some of which have just been described, there are a number of important disadvantageous features connected with the design and construction which might seriously militate against its practical usefulness in the case of high-rate production or long runs. These disadvantages, however, all relate purely to the mechanical and constructional aspects of the whole, and not to the underlying design principles.

These disadvantages are clearly evidenced in the drawing shown in Fig. 3, which is, in effect, a modified construction of the original design, so arranged not only to indicate the nature of the drawbacks about to be considered, but also to illustrate simple yet effective ways in which they may be overcome.

(A) **Lack of Wear Adjustment for Slides**

The first undesirable feature to be emphasized is the absence of any effective means for adjusting the slides in the case of wear. Unless this is provided there will be the risk of considerable trouble developing due to slackness of fit between these slides and their dovetail guideway, which will force the slides to become misaligned with one another and the push pins G out of correct endwise alignment with the insert guide sleeves.

Referring to the illustration, Fig. 3, it will be seen that the guideway in the parting-line surface of the movable block A is widened so as to allow for the introduction of a tapered adjustable gib H. This is so fitted and arranged as to be capable of being clamped down to the block by four screws K. Three adjusting screws J are employed for backing up to lower side of the gib, being housed in tapped holes machined in lower edge of block. The same gib suffices for both slides, and in the case of wear, screws K are first released and the adjusting screws J slightly tightened until the slackness has been taken up, whereupon the locknuts on the screws J are locked down and finally screws K fastened down sufficiently tight to withstand vibration.

This gib member should, of course, be well hardened and closely fitted, and also the two slides should preferably be hardened and ground on their sliding surfaces in the case of moulds intended for very large-scale production.

The location of this adjustable gib should also be noted. It should preferably be located on the underside of a slide which functions in the horizontal plane, so that the weight of the slide is resting upon the gib. This will mean that the bulk of the wear will take place on the gib itself, or the dovetail shear of slide adjacent to it, and not on the uppermost shear of slide. This will mean that any adjustments subsequently made to the gib for correcting wear will serve to

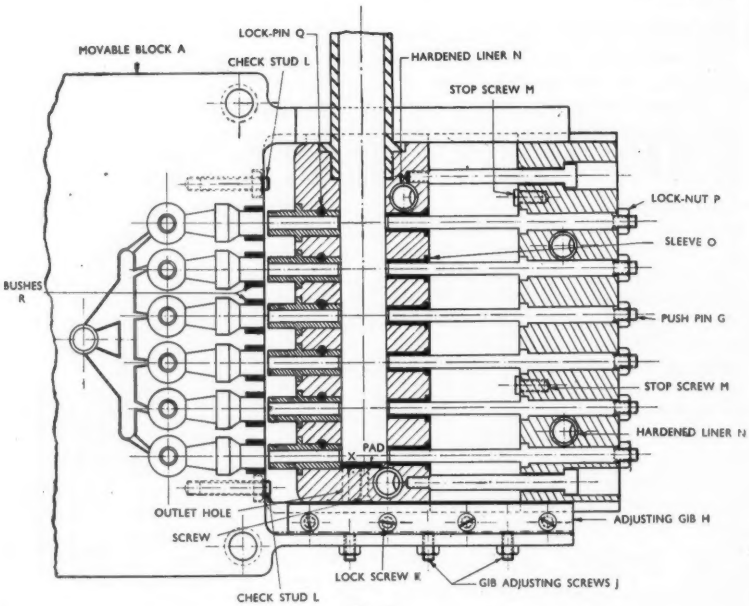

Fig. 3.

hold back the slide to its original position since its upper surfaces will not be worn. If the gib were to be situated on the top side of the slide the bulk of surface wear would occur on the lower shear of slide and guides, resulting in the sliding tending to take a lower position, and so producing misalignment.

(B) Arresting Slide Travel in Closing of Mould

The next important improvement which should be effected to this mould construction concerns the stopping of slides B and E when the moulds are brought to the closed position.

In the illustrations shown at Figs. 1 and 2 it will have been observed that the slide B in its closed location is made to butt directly against the endface of the dovetail guideway cut-out portion in which the slides are housed. Slide E similarly is caused to bear right up against the right-hand endface of slide B.

The disadvantage of such a construction as this lies in the danger of trapping accumulations of dirt, oil, or tiny particles of plastic material, or other solid materials which inadvertently will find ingress into the mechanism and lodgment between the slide faces, etc., which are in intimate contact.

Should this occur and be permitted to proceed unchecked until reaching an aggravated condition, difficulty will be encountered in moving the slides their correct distance, and, consequently, there may be incorrect introduction of insert components into the mould cavities. In addition, presence of such obstacles to free slide movement and positioning may produce undue strain upon the inclined actuating pins, causing them to become strained, distorted permanently, or even seized within the holes in slides. Thus additional and more rapid wear will arise and the need for more frequent adjustments and corrections by the mould toolmaker will be required. In injection moulds it has been repeatedly found from actual practice that large surfaces brought

intimately into contact especially when locating important slides, etc., is very unsatisfactory practice.

To overcome the forementioned possible troubles, two or more check studs as shown at L are employed in the following manner. These studs are threaded for the major portion of their length, and have their head endface finished off perfectly square and flat and, of course, well hardened. Tapping holes are provided in the wall of the mould block A as indicated in Fig. 3, these being appropriately counter-bored for a short distance to allow entry of a locknut of standard pattern which is passed on to the stud L for locking purposes.

These two studs are initially adjusted so that their head portions just nicely clear the wall of block, being locked up in that position. Slide B should then make contact with the heads of both studs when in its closed position, and a slight gap left at all other points.

By this simple means the extent of metal to metal contact is very substantially reduced, and, moreover, adequate space is left for the accumulation of dried-off oil, or lubrication residues, etc., so that little trouble need be expected in this respect.

The mould maintenance engineer will also gain a further advantage from such a provision. Very often it becomes necessary to alter slightly the amount of projection of the push pins into the insert guides. By releasing the locknuts on studs L and adjusting these in the requisite direction, such alterations can be rapidly and easily effected, whereas with the original construction the slide may have to be removed, dismantled, and material machined off its left-hand face to produce differing positioning.

Similarly with respect to the ejector slide E, this is also provided with two stop screws M housed securely in tapped holes in left-hand side of slide. The heads of these screws are allowed to project a very short distance beyond side of slide, so first making contact with the right-hand side of slide B when in the closed position. Here again dirt, etc., will be far less liable to accumulate in such a manner as to produce misplacement of the slide.

(C) Overcoming Wear in Actuating-pin Holes

Because of the great need to avoid wear in the matter of slide fitting the actuating pin holes subject to considerable sliding and frictional rubbing, are provided with specially hardened renewable steel liners shown at N. These are easily renewed as and when wear occurs.

The far-sighted mould maintenance engineer would have at least one complete set of spare liners made up at the time of mould manufacture so being safeguarded against any unusually early or serious wearing.

The effecting of such a renewal will be very quickly made and so the slide would be restored practically to its original degree of fit.

(D) Push-pin Alignment Facilities

Considerable troubles may also be expected from the type of construction in respect of maintaining the correct longitudinal alignment of the push pins G with the slide B and the guide sleeves therein.

It will have been noticed that parallel pins are employed in the original mould lay-out these being press fitted into the slide E. Such a method of fixing is notoriously inefficient and likely to give trouble in the form of frequent stoppages for correction and readjustment of push pins which have gradually been pushed back within their housing in slide E.

Fig. 3 shows a very effective and inexpensive way to overcome such tendencies. Each pin is made with an enlarged shoulder, as at G, and the holes at the left-hand side of slide E are each recessed so that this shoulder is completely sunk below endface. The other end of the pin is threaded and extends beyond the right-hand side of slide so that lock-nuts P can be employed. This plain shank portion of the pin is also made a press-in fit into hole in slide and the whole pin clamped up by nut P, thereby positively preventing any endwise shift.

Should it become necessary to effect an alteration in the endwise setting of these pins it will be a comparatively easy matter to remove them and machine off a slight amount of stock from the back face of head, or to interpose a thin shim washer between the head and bottom of recess in slide so as to give the required amount and direction of adjustment.

Instead of these pins G fitting straight into plain holes in slide B, each hole in this latter member is enlarged and bushed out with hardened sleeves O. These parts, it will be seen, are provided with enlarged heads similarly sunk within recessed portions of the slide B. By having such renewable and specially hardened bushes, it will be far easier to maintain that good degree of fit and freedom from deleterious wear between push pins and the slide. This may produce several useful advantages in other respects. Thus, where bushes of this kind are not used, excessive wear may entail the making up of a completely new slide B with all its consequent loss of production time and additional expense. Or, a very harmful seizure of the push pins in slide B may be avoided.

If the pins are made of hardened tool steel it might be advisable to use a good-grade phosphor-bronze for these hole liner bushes, and the wear-resisting qualities of such a combination would be very great.

(E) **Modified Insert-holding Quills**

It is also highly desirable to arrange for a very similar provision to the above in respect of the insert holding tubes D. In the construction of Figs. 1 and 2 these are straight tubular members driven tightly into holes machined in B.

Reliance for safe retention and correct positioning is therefore entirely dependent upon the degree of tightness of this fit. Under actual operating conditions with such factors as variable mould temperatures, vibration and unequal expansion and contraction, it is almost certain that some loosening effect will speedily develop, resulting in the tubes becoming displaced from their correct anchorage. If this occurs their right-hand ends may be pushed back into the rectangular slot in slide B there to interfere with the fall and feeding of further inserts. On the other hand, the tubes may be drawn out of the slide B and thus caused to pass too far into cavity area, which will mean a defective moulded article, since the left-hand end of the tubes is used for sealing off the cavity.

If these tubular members are made in the manner illustrated in Fig. 3 such troubles will scarcely arise. Each one is made having an enlarged shoulder portion approximately mid-way along its length. This shoulder is then housed in a recess formed around each hole at the left-hand side of the slide B. The plain shank to the right of this shoulder is, of course, a tight press fit into the slide, and rotation or endwise movement is further restrained by means of small steel pins Q located crosswise half in tube wall and half in slide, as shown. By this method of fixture no independent movement of the tubes can occur, yet if wear of a tube should necessitate replacement pin Q is easily extracted and the tube removed.

Before leaving this matter of insert-holding quills or tubes, there is one highly desirable feature worth noting. In numerous applications it will be found necessary for the insert component to be gripped with a certain degree of power in order to obviate it being moved by reason of vibration from other moving mould members.

Obviously, the insert cannot be left fitting slackly within the bore of tube, and, on the other hand, the fit must not be too tight, otherwise the push pins and ejector slide E will have greatly additional work in moving inserts from the magazine to mould area.

Thus it will almost always be found necessary to install some means whereby the part is held with sufficient frictional grip to prevent it from becoming vibrated out of correct position with tube bore, or from being held too tightly. Hence it will be desirable to have the

insert holding tubes so adapted as to impart a degree of "springiness" to their forward ends. For suggestions as to preferable means for performing this the reader is referred to earlier discussions in this series where suggestions were made for useful designs.

The forward portions of the insert holders which engage the parallel cavity extensions in block A should also be provided with some simple means to arrest and correct developing wear. This is accomplished by employing specially hardened steel bushes R, which are very tightly press fitted into these holes, as shown in solid black shading in Fig. 3.

(F) Adjustment of Magazine Depth

In connection with the magazine construction for stacking a supply of inserts in readiness for each shot, two serious disadvantages are worthy of careful notice.

The first is in respect to dirt and oil, which will inevitably be carried into the magazine chamber largely by the inserts themselves. This dirt, etc., will tend to accumulate on the floor of the slot, as indicated at X in Fig. 3. If uncorrected, this will eventually interfere with the free passage of the inserts and will result in the whole column of such components being misaligned vertically with the bores of sleeves D. This, in its turn, will cause stiffened working of slides, additional strain upon push pins, and greater wear on bores of insert quills.

The second point concerns the risk of wear which will occur on the face X, due to the weight and sliding friction of the inserts themselves.

The method for overcoming this is both simple and effective, and is clearly illustrated in Fig. 3. The magazine floor is machined somewhat lower than is the case in the construction, Fig. 1, and fitted to it is a hardened-steel plate S held in position by screws T passed up from bottom of block. The top of this plate is made exactly level with the bottom of the lowest hole in slide. It is also made slightly shorter than width of slot so that two small gaps are left at each end. The purpose of these gaps is to act as reservoirs for any dirt, etc., which might find entry into slot. As will be seen, small outlet holes are then connected up to these gaps and pass down through wall of block A to its outside edge. Thus the normal sliding action of the push pins operating against the inserts will tend to wipe the slot base clean, any dirt falling out of space down outlet hole to exterior of block.

(G) Lack of Check on Slides in Open Position

Unless it is possible to arrange the mould block opening in such a manner that the angular operating pins do not disengage the slides B and E, there will be some danger of these members being disturbed when in the open position and so causing a jam when the moulds are next closed.

The author would strongly urge the provision of some simple device whereby each slide is positively held against accidental displacement. Although no illustrated remedies are here shown, perhaps one of the simplest methods would be to install a spring-loaded plunger in the mould block at A at a convenient point behind the slides, which plunger would engage a slot or dimple at the back of slide when latter reached its maximum open position.

(H) Preventing Jamming of Inserts in Magazine

One final possible danger calls for some consideration. In cases where the diameter of the insert component is fairly large, meaning that the column of inserts within the magazine tube will have to fall an appreciable distance when push pins are drawn backwards, it may be found that the sudden drop will cause some of the inserts to jam diagonally within the magazine slot.

To overcome this, small spring-loaded plungers should be fitted into the slide B so as to project slightly into the magazine slot. The aim of such plunger application being to support the stack of inserts to some extent. The plunger should be capable of holding one insert component,

but not the whole stack within the magazine.

Maintenance Services Needed with This Modified Construction

Given the constructional and mechanical modifications just described, whereby all the chief possible sources of error, wear and trouble are well covered, it is difficult to foresee any serious operational snags. It will be found that the main attentions of the maintenance engineer will centre around maintaining the mould mechanism in a clean, well-lubricated condition, and the adjustment of the two slides carefully watched.

Where detachable magazine tubes, as at C, are in use, these being filled up with their supply of inserts from any outside sorting and delivery device, it may be necessary to arrange some simple closure arrangement to the bottom end of the tube so that handling of a loaded member is facilitated.

Again some attention will be required from time to time to the means for fixing the detachable magazine C to slide B. Where this is by means of a thread joint as in the illustrated example, tests will have to be made at regular intervals to ensure that the rectangular bore of tube maintains alignment with slot in slide. Frequent screwing and unscrewing of the former part may eventually produce a certain degree of slackness which would allow the tube to be screwed round a little too far and thus throw it out of line with slide slot.

The slide gib will also require repeated testing to ensure it is always adjusted to prevent any wobble or undue slackness of slides. Lubrication will also play an important part in this connection and means should be provided to present adequate lubricant to these members.

The push pins G might also be usefully machined with two diametrically opposed flats along their length so as to relieve the frictional contact with bores of slide B, etc., and also to allow free access of oil.

A Novel Sorting Mechanism for Use With Foregoing Mould

It will be realized that the successful working of the insert feeding mechanism just described depends upon each insert being fed the correct way to the magazine slide, etc. Each part must without fail

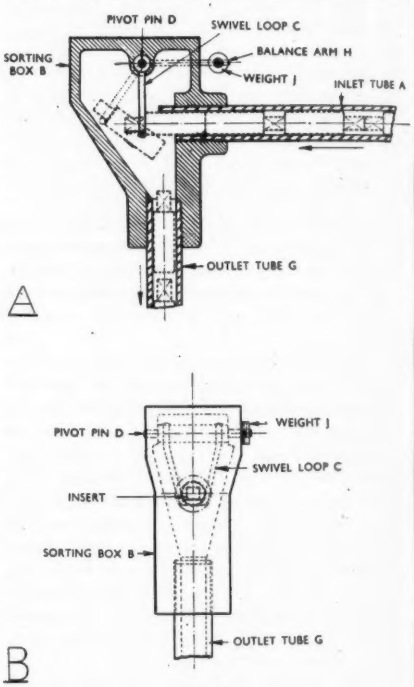

Fig. 4.

be fed into the magazine with its reduced squared end foremost.

This is simply accomplished by employing a sorting device of the type illustrated in Fig. 4, which was interposed between a large container housing a very large quantity of inserts indiscriminatingly thrown in, and the outlet for filling the detachable magazine tubes C.

This sorting device consists of the following. First a specially funnel-shaped container capable of holding several hundreds of inserts was set up on trunnions bracketed to a table and

arranged so that a slight vibrationary motion was imparted to the funnel. This was required to keep the inserts in a state of agitation and movement to cause them to fall through the outlet tube of small diameter at base of the container.

This outlet tube was bent to follow a vertical path until almost approaching the sorting device illustrated in Fig. 4. Just prior to connection with this latter the tube was given a right-angled bend so as to form the sorting box inlet tube A.

The reason for this right-angled bend from vertical to horizontal being to utilize the weight of inserts for operating the sorting mechanism as will now be described.

Turning to the upper sectioned cut A in Fig. 4, the inlet tube A is shown attached to the vertical wall of a hollow box B. Incoming insert components are shown approaching the sorting box in heavy broken line, it being particularly observed that these parts are not sorted as regards position of the squared end.

The actual sorting is performed quite simply by means of a swivel loop C made from light gauge round steel wire. The lower view B shows the form of this loop. It approaches closely to a triangle and is arranged to swivel on the fulcrum pin D passing through both side walls of the sorting box.

A vertically located outlet tube from the sorting box is shown at G, down which the inserts flow always with the squared end uppermost as indicated by the heavy broken line.

The swivel loop member C is so arranged in vertical relationship to the end of inlet tube A that if an insert comes along with its square end foremost this squared portion will pass over the horizontal bridge at bottom of loop C when this is in its vertical position. This is shown in full line in the upper view A when an insert has just engaged the loop in this manner. Continued pressure from the inserts behind the one thus caught on the loop causes the latter to swing around as illustrated, thereby raising and holding the square end of insert in a somewhat elevated position until the opposite end has been pushed clear of the end of inlet tube A. Immediately this occurs the insert will then fall large end first down the box and through the outlet tube G.

Should an insert pass through into the sorting box large end foremost this cannot pass over the horizontal bridge of loop member C and this latter will simply be pushed upwards until the insert falls square end uppermost down the box and outlet tube G.

Thus in this simple yet sure manner every insert is correctly positioned before passing out of the sorting box.

In order to ensure that the swivel loop C is always returned to its vertical position in readiness for the receipt of the next insert, the pivot pin D is equipped with a balance arm H to which is attached a weight J. This weight should only be sufficient to counteract the weight of the loop C and preferably should be so arranged as to be adjusted along the arm H.

This type of sorting mechanism will be found applicable to numerous shapes of insert component, and will ensure very rapid delivery of parts all correctly positioned.

Very slight modifications of the design will permit the mould designer to employ this method for hollow inserts for instance, where instead of having a loop there should be a swivelling hook at the bent over end capable of passing up the hollow end of the insert and lift is upwards in the same manner as with the squared end parts just dealt with.

The maintenance service attendant upon a device of such a simple nature as this will be very small. Care will have to be taken to ensure that dirt or solidified oil do not choke up the walls of the inlet tube A, or that the bearings of the swivelling loop C are not allowed to become tight from lack of lubricant so that the loop will not function at the slightest touch. Very little pressure is required for this member.

Doubtless mould designers will find this simple sorting design will be of interest and maybe suggest other developments or

modifications for meeting sorting needs of any particular form of insert.

The success of many insert automatic feeding mechanisms is dependent upon the sorting out device working in conjunction, and the author could give numbers of very interesting, extremely simple, and inexpensive arrangements for accomplishing such sorting functions. Unfortunately space prevents any further attention being given to this aspect of the subject.

Conclusion

In the next section the author will deal with a number of equally interesting design forms where inserts have to be fed to awkwardly situated mould cavities and where it is necessary to utilize a revolving cylinder and gearing for the transfer of inserts from the magazine to the mould cavity locations.

This will embrace another useful and indeed well adopted type of insert feed, and again it is hoped its presentation will indicate numerous ways in which similar mould layouts may be dealt with by automatic feeding.

Special attention will be given to the need for adopting those mechanisms capable of functioning at high speeds, and for application to multiple cavity moulds.

WET STRENGTH OF PAPERS

(Continued from page 175)

into this matter, and the nature of the paper itself may influence a deterioration of wet strength with age. As regards melamine paper, there is a slight disadvantage from the papermakers' viewpoint, because such paper is more difficult to defibre in form of waste. A very large proportion of paper demanding enhanced wet strength, however, does not appear as salvage.

Yet another means that is being actively examined for improving wet strength is the employment of emulsions of some of the polymers. Among these is polyvinyl acetate. Emulsions of this type can be added to beaters or existing baths used for the production of special papers with breakdown. No hardener or catalyst is necessary.

Finally, there are available the methods which entail the use of additional plant such as dipping baths containing resins in organic solvent. In many ways these give excellent results, often introducing the additional advantage of being fungus- and insect-proof.

Society of Dyers and Colourists

This Society will hold an important Symposium on the subject of Fibrous Proteins, Natural and Synthetic, on May 23, 24 and 25, 1946, in the University, Leeds.

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These will be published in galley-proof form early in May at a price which will be announced as soon as possible. This price will include subsequent delivery of a bound volume, which will be complete with reports of the discussions, etc.

It is proposed that the person presenting the paper will give a short summary of about 10 minutes' duration, after which some 20 minutes will be available for discussion.

By the courtesy of the Vice-Chancellor (B. Mouat Jones, Esq., D.S.O., M.A.), facilities at the University of Leeds have been placed at the disposal of the Society for the presentation of the papers. It has also been arranged that parties may visit the Electron Microscope, the Brotherton Library and other features of interest at the University. There will also be exhibits of Natural and Synthetic Fibres and Fabrics, etc.

The Society has been able to secure a certain amount of hotel accommodation for the evenings of Wednesday, Thursday and Friday, May 22, 23 and 24, 1946, in Leeds, Bradford and Harrogate, but early application will be necessary to Mr. H. Foster, the Honorary Secretary of the Symposium Committee, at the Society of Dyers and Colourists, 32-34, Piccadilly, Bradford, England.

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Agencies required for the sale of plastic domestic articles. Representatives covering most part of the British Isles. Write to N. Gerver (Building and Utility Supplies Dept.), 2-10 Mare Street, Hackney, London, E.8. 109-6339

Export merchants, exporting to Europe, India and Africa, invite offers from manufacturers of plastic goods; large orders. Apply, Box 47, care of "Plastics." zzz-375

Trained and experienced Sales Manager, operating established agency business in Glasgow, can handle one other commission. Advertiser has some knowledge of plastics and is conversant with marketing to manufacturers, wholesale merchants, departmental and chain stores and also retailers. Usual commission terms. Address 1431, Wm. Porteous and Co., Glasgow. 107-4

Manufacturers of Perspex fancy and household goods wish to contact sales organization to buy the whole output for own account or to work on commission basis, for export and home trade. Box 1424, care of "Plastics." 107-9

Patentees of domestic table ware, etc., desire to contact plastic manufacturers and moulders. Box 1270, care of "Plastics." 107-x1395

BOOKS AND PUBLICATIONS

Books on Plastics: Plastics, Scientific and Technological, by H. R. Fleck, 30s. 6d.; Plastics in Industry, by Plastes, 15s. 6d.; Handbook of Engineering Plastics, by D. Warburton Brown, 18s.; Synthetic Resins and Allied Plastics, edited by R. S. Morrell, 38s.; Plastics and Industrial Design, by John Gloag, 10s. 10d.; Plastics for Production, by Paul S. Smith, 12s. 10d. These prices include postage. The Modern Book Company, Dept. T.2, 19-23 Praed Street, London, W.2. Pad. 4185. 107-16

BUSINESSES, PREMISES, OFFICES, ETC.

Plastics manufacturing company wish to dispose of same, together with small London factory. Fully equipped with new hydraulic presses (downstroke), fly presses, drills, lathes, etc., new mould tools, quantity of moulding powder, sheet plastic material, etc. Rent £85 p.a. Price inclusive, £1,500. No offers. No agents. Box 1498, care of "Plastics." 107-x2183

Businesses, Premises, Offices, etc., Wanted

Small plastic factory in London area as going concern required. Replies will be treated in strict confidence. Box 1273, care of "Plastics." 107-x1424

FINANCIAL AND PARTNERSHIP

Partnership or directorship required in any branch of plastics industry. Able to work as accountant or secretary, but open to any offers. Small capital available. Write, giving full details in confidence or make appointment. Box 1385, care of "Plastics." 107-x1814

MACHINERY, TOOLS AND PLANT

New steam steel platens for hydraulic presses, all sizes, available for delivery about two months. Inquiries invited. Box 1430, care of "Plastics." 107-2

Machinery, Tools and Plant (contd.)

One M.S. Enclosed Receiver Tank, 26 ft. long, 5 ft. 6 ins. dia., made from ⅜-in. plate; double riveted; price £150.

One horizontal M.S. jacketed vessel with stirring gear, 12 ft. long, 5 ft. dia., made from ⅜-in. plate; price £225.

Two vertical C.I. enclosed mixing vessels, 36 ins. dia., 45 ins. deep, radial arm type agitators on vertical shaft; driven through bevel reduction gearing by camshaft with fast and loose pulleys, side feed hopper and bottom outlets 12 ins. by 8 ins. to be in good working condition; £95 each.

One horizontal chemical mixer with ⅜-in. thick antimonial lead barrel mounted on heavy C.I. rocker stands, with gunmetal shaft and agitators; driven by fast and loose pulleys; price £85.

Reynolds, Mann Place, Domestic Street, Leeds, 11. 107-5620

PRODUCTION CAPACITY AVAILABLE AND WANTED

Cosmetics. Containers for lipsticks and fancy jars for creams wanted in plastics for export by Ivey Palmer, Ltd., 13 Disraeli Gardens, London, S.W.15. 107-x7078

Repetition in Ebonite, Erinoid, etc. Capstan lathe work. Mansell, Temple Street, Rugby. 113-5069

Pulverizing and Grading of raw materials. Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-369

Engraved name plates, scales, dials, etc., supplied. Tickets and Co., Silver Street, Leicester. Phone 21218. zzz-374

Wholesalers, supplying home market, require large quantities of all types of plastics. Of interest to manufacturers with large production requiring steady outlets. Our buyers will call if you write. Box 42, care of "Plastics." 108-6168

Injection moulding capacity wanted with firms able to offer long runs. Several moulds available, ranging from ¼-oz. to 3-oz. shots. Box 140, care of "Plastics." 108-6171

100-ton capacity available for thermo-setting materials; electrically heated platens. Box 1559, care of "Plastics." 107-x2299

London firm requires for home and export markets, plastic household goods, including beakers, cups, saucers, plates, spoons, etc., in urea or phenol formaldehyde. Box 1427, care of "Plastics." 112-6341

Toolmaking firm (Birmingham) considering production of injection or pressure mouldings invite inquiries. Box 108, care of "Plastics." 107-21

Required, moulding capacity, preferably injection for long runs up to three years. Apply, Box 46, care of "Plastics." zzz-376

Important firm requires premises equipped with plant suitable for production of P.V.C. in sheet form and in extruded form; injection machines would be suitable. Box 1571, care of "Plastics." 107-x2414

Capacity available for small plastic articles or components, on tool cost basis for advertising purposes, etc. Box 1422, care of "Plastics." 107-7

Moulding capacity available for long runs, ½ to ½ oz. shots, injection. BCM/SQUARE, London, W.C.1. 107-x1710

Capacity immediately available for jig and tool making and production work; precision work of highest quality carried out with the latest-type machine tools. Pye Motors, Ltd., Lancaster. 107-x1268

We want any available goods for export.

We have over 1,000 buying agents and correspondents in India, Burma, Ceylon, Egypt, Turkey, Syria, Iraq, Persia, East and West Africa with huge buying potentialities, who can give manufacturers an ever-increasing, permanent trade with cash payments no bad debts. Write us first of all, giving full details of whatever you can supply, with best possible wholesale export trade prices and illustrated details.

Quillian Products.

22 High Street, Kingston-on-Thames. 107-27

Manufacturers of articles from Perspex, now released from war contracts, can undertake contracts and speciality work. Types of goods produced: radio, car and aircraft parts, fancy goods, household goods, parts for building trades (with necessary permits), and allied trades. Woodworking capacity also available. All inquiries will receive prompt attention. Box 1470, care of "Plastics." 107-x2064

Capacity for the designing and manufacture of wooden forming tools for thermoplastic sheet, and laminated. Inquiries to Box 1646, care of "Plastics," or phone Rav. 1155. 107-28

SITUATIONS VACANT

Designer-Draughtsman required for factory, Romford, Essex, with thorough knowledge of injection moulding tool design; must also be capable of jig and tool design for light engineering work. Permanent position for the right man. Write full particulars to Box 1621, care of "Plastics." 108-6371

Situations Vacant (contd.)

Technical Representative, with good personality and proved sales record, required by leading firm of plastics manufacturers for Scotland, must have sound knowledge of phenolic plastics, and preferably a good engineering background. Applications, giving full details of technical and sales experience, age, etc., should be addressed to Messrs. Birkbys, Ltd., Liversedge, Yorks. 107-5938

Technical expert required, thorough knowledge of modern plastic materials to initiate tool design for use in production of plastic articles. Box 38, care of "Plastics." 108-6167

Leading firm of moulders require the services of a capable technician to take charge of tool design office. Applicants must provide full proof of service in the plastics industry, be fully up to date, and prepared to bring new and up-to-date ideas with them. Copies of recent references should be submitted. Write, stating age, particulars of experience and salary required, to Box 9556, care of "Plastics." 107-5944

Manager, storekeeper and order clerk wanted for plastic and photographic material business. Lloyd's, 72 Bridge Street, Christchurch zzz-49

Technical manager required by large Australian plastics company engaged in compression moulding and injection, extruding, calendering and spreading of thermoplastics. Applicant should be aged about 35, with thorough practical experience in the plastics or rubber industry. Suitable arrangements will be made regarding salary and transport. Apply in writing, with very full particulars of education, experience, copies of references, personal details, and enclosing recent photograph of applicant, to Box 1331, care of "Plastics." 107-x1661

Toolmakers and skilled craftsmen required for factory, Romford, Essex. Exceptional ability required for which adequate remuneration will be made. If you are confident of your ability write, giving full details, to Box 1622, care of "Plastics." 108-6370

Foreman for plastic, moulding and extrusion shop in well-established London firm; permanent position; good general education, modern outlook and experience of labour essential. Give age, salary and experience in full. Box 1623, care of "Plastics." 107-22

Moulding Shop Foreman-Manager. Position is open with established moulding concern in London area. Applicant must have complete practical knowledge of both compression and injection moulding, etc., and has to take charge of entire production. Application, with all details of experience and references, to Box 1625, care of "Plastics." 107-24

Wanted for the plastic department (to be newly started) of an established brush-making concern in South India —Palghat—a works foreman of plastics plant, both compression and injection, with knowledge of mould design. Must be able to serve minimum five years; free quarters. Write, stating age, full particulars and salary required, to Box 1429, care of "Plastics." 107-13

Practical Foreman for medium size plant (compression) in Midlands (rural district). M. and F. labour. Interview London arranged. State experience, age, wages required. Box 1546, care of "Plastics." 107-17

Courtaulds, Ltd. A Technologist is required for plant manufacturing thermo-plastics comprising moulding powders, sheeting and extruding sections. Experience of investigational work in the rubber or plastics industry is desirable, and applicants should be between the ages of 21 and 40. A detailed questionnaire will be sent to applicants who write to the Director of Personnel, Courtaulds, Ltd., 16 St. Martins-le-Grand, London, E.C.1. 107-14

Two Draughtsmen required for tool design office. Experience of mould design an advantage, but not essential. A.E.S.D. rates. Write, stating age, and particulars of experience, to Personnel Manager, E. K. Cole, Ltd., Southend-on-Sea. 109-6340

Hons. Grad. Chemical Engineer for senior administrative post, new Kent coast industry. Modern factories, good house available. Salary £850 to £1,500 p.a. according to qualifications and experience. Organic Chemist and Physicist also required. Box 1549, care of "Plastics." 107-20

Chemist, senior assistant, male, age 25-35, for research work on thermo-setting resins and laminated plastics. Apply by letter, giving full details of education and experience and state salary required. Advertising Dept., Tufnol, Ltd., Perry Barr, Birmingham, 22B. 107-3

Highly experienced and energetic Works Manager with first-class administrative experience required for plastic factory capable of considerable expansion. Knowledge of moulding manipulation and design in perspex and acetates, etc., essential. Commencing salary £900-£1,200 per annum. Write, Box 25, care of Crossley and Co., Ltd., 5 Racquet Court, Fleet Street, E.C.4. 107-5

Situations Vacant (contd.)

Foreman required for small factory. Mechanical knowledge essential, practical experience with plastics desirable. Write, stating age, salary required, and experience to Box 1421, care of "Plastics." 107-6

Fillers, Factories equipped for making finely powdered fillers require sales manager. Persons with experience and ideas please reply to Box 1423, care of "Plastics." 107-8

Technical representative for synthetic resins, cements, lacquers and varnishes, to handle these exclusively in the London and Home Counties area. Sound chemical and technical background essential, with wide experience in the application and sale of these products. Apply, with fullest details of training, experience, salary, age, etc., to Box 1425, care of "Plastics." 107-10

Manager-Foreman wanted by well-established plastic moulding firm near London. Full practical knowledge required in compression and injection moulding. Applicant has to take full charge of production. Excellent opportunity for the right person to get into executive position. Reply Box 1624, care of "Plastics." 107-23

SITUATIONS WANTED

Export Sales Manager of Plastic Moulding Company seeks position in London. Conversant with present-day export conditions, also knowledge of wholesale hardware trade from manufacturers' angle. Box 9421, care of "Plastics." 107-x2597

Technical assistant, long experience in moulding firm, seeks responsible administrative appointment where initiative, technical knowledge and war-time administrative experience can be used fully. Qualified City and Guilds Technology of Plastics. Box 1443, care of "Plastics." 107-x1987

Estimator, 5¼-years' experience London moulders, desires change to progressive firm; estimating, sales, development departments. Box 1442, care of "Plastics." 107-x1987

Plastics position required by young married man, holder plastics certificate, capable undertaking technical work, prefer London or southern counties. Box 1471, care of "Plastics." 107-x2028

Photography, first-class operator, studio and out-door, sound knowledge and initiative, seeks responsible post in or near London. Box 1547, care of "Plastics." 107-18

Senior executive, available shortly, desires change; injection, transfer and compression moulding; very modern experience of production, material and costs control; high qualifications and excellent references. Box 1250, care of "Plastics." 107-x1364

WANTED

Acetate and Nitrate. Sheet off-cuts and scrap plastic materials of every description wanted. We can arrange collection. Top prices paid. Lloyd's, 72 Bridge Street, Christchurch, Hants. Phone, Christchurch 504. zzz-51

Injection moulding machine wanted for Cellulose Acetate, etc., any type considered. Healey Mouldings, Ltd., Tamebridge, West Bromwich Road, Walsall. 108-6169

Urea and Phenol Moulding Powder in all colours. Large or small lots. Box 9035, care of "Plastics." zzz-371

Scrap Perspex or similar material required, three tons monthly. Offers to Box 1643, care of "Plastics." 107-26

Well-equipped machine shop wishes to manufacture moulding presses, adequate plant. Would act as sub-contractor to existing manufacturer or by arrangement with substantial organization having suitable designs. Box 1626, care of "Plastics." 107-25

Wanted, black phenol moulding powder or any other colour, small or large quantity, good price paid. Box 1444, care of "Plastics." 107-x2000

Heavy plastic sheets required, all shades, by manufacturer of handbags. Plain and embossed. Samples and prices to Liversidge, North Parade, Whitley Bay. 107-x2170

Electric lamp bases. Lamp-shade manufacturer seeks competitive bulk supplies of attractive lamp bases of all types, including perspex, casein, wood, pottery, etc. Box 8717, care of "Plastics." 107-5288

Electric moulding presses, 50-200 tons; also injection moulding machine. Price and details, Box 1589, care of "Plastics." 107-x2508

Urea and phenol moulding powders required in quantity. State types and colours. Box 1271, care of "Plastics." 107-x1394

Advertisers require to purchase 1 to 1½ tons per month marble powder or inert filler to a close grading specification. Offers to Box 1647, care of "Plastics." 107-29

Wanted (contd.)

Wanted, circular off-cuts of every description; all sizes, all materials; plastics, wood, rubber, metal, etc. Send details and prices to Box 1548, care of "Plastics." 107-19

Modern Extruding Machines, large size, Francis Shaw or similar. Box 8328, care of "Plastics." 109-5943

MISCELLANEOUS

Pulverizing and Grading. Reduction of most thermoplastics down to 200 mesh undertaken by Dohm, Ltd., 167 Victoria Street, London, S.W.1. 108-4533

Factory Time Recorders. Service rental. Phone, Vigilant 4731. Time Recorder, Supply and Maintenance Co., 28 Mayfield Road, Sutton, Surrey. 113-5065

Polyglot Translation Service, Ltd., Terminal House, 52 Grosvenor Gardens, London, S.W.1. Phone, Sloane 7059. Translations of every description. All languages. 107-5066

Grained moulding plates and rollers any pattern. J. Martin and Sons, Ltd., Park Street, Ardwick, Manchester, 12. 110-4421

Limited Quantity solid rubber-tyred steel wheels in excellent condition, 16 ins. dia., with solid rubber tyres, approximately 1½ ins. thick by 2⅝ ins. wide by approximately 19 ins. overall. Fitted with ball races 1 9/16-in. bore. Ideal for portable plant, concrete mixers, crushers, etc. Price 60s. per pair delivered; £5 10s. per set of four delivered or pro rata. Cash with order. Reynolds, Mann Place, Domestic Street, Leeds, 11. 107-5619

Monomarks. Permanent London Address. Letters redirected, 5s. p.a. Write, Monomark BM/MONO76, W.C.1. 110-5942

Perspex, small sizes, 1/24-in.-⅜-in., 1d.-1¾d. sq. in. Kanga, 1 Colonnade Passage, Birmingham 109-6170

Plastics. P.V.C. sheeting, first quality, lowest price, with samples requested. Benfrey, Ltd., Dominion House, Bartholomew Close, E.C.1. 107-x1933

You have a job which needs plastic fabrication. Send your requirements to us. "Proplas" (D. F. Neville), 34 Lower Richmond Road, Putney. 107-x1548

Perspex small offcuts, clear and colour, for sale. Write, Box 1545, care of "Plastics." 107-15

Extend Your Trade.
Use a Trade Mark. Consult
Trade Mark Protection Society,
12 Church Street, Liverpool. 118-6372

Miscellaneous (contd.)

Models. The Design Group, Ltd., are, from time to time, able to accept assignments for model making of any kind from clients who require the finest craftsmanship and results.
The Design Group, Ltd., Commonwealth House, W.C.1. Chancery 6451 (10 lines). 107-x2439

Hydraulic press for disposal. Size of platens 84 ins. by 66 ins., 40-in. daylight, 14-in. ram, six columns, very heavily built, can be seen working London. Could be adapted to various methods of manufacture. Box 1426, care of "Plastics." 107-11

Continuous arisings P.V.C. and polythene cable-strippings, also other thermoplastics. Apply Box 1428, care of "Plastics." 107-12

Cellulose Acetate.
6 tons tinted sheet, size 55 ins. by 24 ins. by .010 thick, packed in original boxes, interleaved with tissue paper, make Halex, at greatly reduced price.
Almex Recovery and Refining Co., Ltd., 120 Moorgate, London, E.C.2. Clerkenwell 3351. 107-1

Moulding powder for sale, 30 cwt. Bakelite X250 heat-resisting and 40 cwt. Bakelite X199 shock-proof. Box 1272, care of "Plastics." 107-x1424

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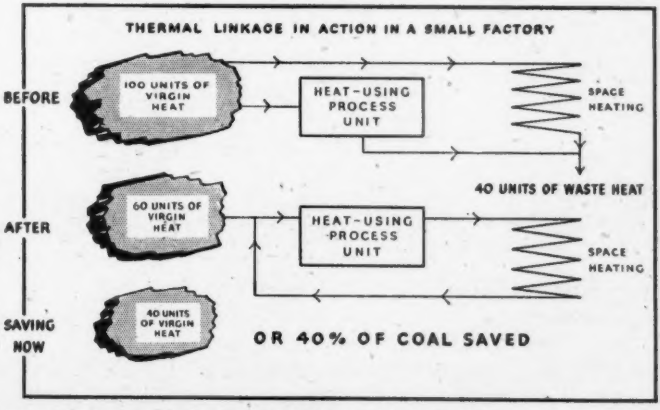

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General information on the basic principles of THERMAL LINKAGE will be found in *Fuel Efficiency Bulletin* No. 21 (" The Construction of a Factory Heat Balance "). For specific advice and guidance you are invited to get into touch with your Regional Office of the Ministry of Fuel and Power.

ISSUED BY THE MINISTRY OF FUEL & POWER

APRIL, 1946. Vol. X. No. 107 **Plastics** ONE SHILLING & SIXPENCE

THE SEVEN AGES OF PLASTICS MAN—2.

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learning geography from a plastics globe . . . doing geometry with plastics drawing instruments and plastics shapes . . . exercising in the school gymnasium on a plastics vaulting-horse . . . eating his mid-day tuck from plastics tableware. Soon, maybe, he will be dabbling in plastics physics in the school laboratory. The Schoolboy of to-day is tomorrow's purchaser of plastics articles — whole ranges of which are as yet unmade and uninvented. Erinoid technicians are increasingly being called in to confer with manufacturers planning new plastics productions. Our experience covers the field of plastics developments, and is at your prompt disposal

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